Homework 18 (Due Thursday, April 19th)

1. Consider the Dieterici equation of state,

$$P = \frac{nRT}{V-b}\exp\left(\frac{-a}{nRTV}\right)$$

where a,b are physical constants.

(a) Find the critical volume, V_c, and temperature T_c in terms of a, b, n, and R.

(b) Show that the pressure at the critical point may be written as,

$$P_c = \mathcal{C}\,\frac{nRT_c}{V_c}$$

and find the numerical constant, $\mathcal{C}$.

2. (a) Defining

$$\pi = \frac{P-P_c}{P_c} \qquad \psi = \frac{V-V_c}{V_c} \qquad \tau = \frac{T-T_c}{T_c}$$

show that for the Dieterici equation of state (see previous problem) that near the critical point

$$\pi \approx 3\tau - \frac{2}{3}\psi^3 - 2\tau\psi$$

(b) Taking ψ as the order parameter find the critical exponents β, γ, and δ. [Hint: Follow the derivation for the van der Waals gas given in Section 12.2 in Pathria and Beale]