Phys 404
Spring 2011
Homework 11, CHAPTER 10
Due Thursday, May 5, 2011 @ 12:30 PM

The final exam is May 17, 1:30-3:30 PM, and will cover the entire course. A single 8-1/2" x 11" crib sheet is allowed. No books, electronics/screens, or calculators are allowed.

1. K+K, Chapter 10, Problem 1, Parts (a) and (b) only

2. K+K, Chapter 10, Problem 2

3. K+K, Chapter 10, Problem 3

4. K+K, Chapter 10, Problem 4 assume that each three-dimensional harmonic oscillator has allowed energies given by $(n_x+n_y+n_z)\hbar\omega-\varepsilon_o$, where n_x, n_y, and n_z are independent non-negative integers and $-\varepsilon_o$ is the ground state energy.

For part (b) you must actually solve for the latent heat per atom.

5. Given the van der Waals equation of state $\left(P+\frac{N^2a}{V^2}\right)(V-Nb)=N\tau$, eliminate the quantities a, b, and N, in favor of P_c, V_c, and τ_c, defined as $P_c \equiv \frac{a}{27\,b^2}$, $V_c \equiv 3Nb$, and $\tau_c \equiv \frac{8\,a}{27\,b}$. Show that the resulting equation of state is $\left(\frac{P}{P_c}+3\left(\frac{V_c}{V}\right)^2\right)\left(\frac{V}{V_c}-\frac{1}{3}\right)=\frac{8}{3}\frac{\tau}{\tau_c}$.

6. Starting with the "law of corresponding states" $\left(\hat{p}+\frac{3}{\hat{v}^2}\right)\left(\hat{v}-\frac{1}{3}\right)=\frac{8}{3}\hat{\tau}$ in terms of the dimensionless quantities $\hat{p}=\frac{P}{P_c}$, $\hat{v}=\frac{V}{V_c}$, and $\hat{\tau}=\frac{\tau}{\tau_c}$, show that the simultaneous conditions $\frac{\partial\hat{p}}{\partial\hat{v}}=0$, and $\frac{\partial^2\hat{p}}{\partial\hat{v}^2}=0$ are satisfied when $\hat{v}=\hat{\tau}=1$. What is the corresponding value of $\hat{p}$? These conditions define the critical point of the van der Waals fluid.