Physics 140B, Winter 2010
Homework 5 --- due Feb 25

1. Solve Problem 2-6 of Carter.

2. Solve Problem 2-7 of Carter.

3. Consider a gas that obeys a modified van der Waals equation of state, namely

$$(P + a/v^3)\,(v - b) = RT\,,$$

where v pertains to one kilomole of the gas. Determine the critical parameters P_c, v_c and T_c of this gas and evaluate the quantity RT_c/P_cv_c .

4. In Problem 3, introduce the "reduced variables" P_r, v_r and T_r to write the equation of state in its "reduced" form.

Next, introduce the variables P', v' and T', defined by

$$P_r = 1 + P',\ v_r = 1 + v',\ T_r = 1 + T',$$

which results in an equation in terms of P', v' and T' . Using this equation, evaluate the "critical exponent" δ of this gas.

5. The equation of state of a gas is given by

$$\frac{Pv}{RT} = 1 - \frac{1}{2}\beta_1 \frac{\lambda^3}{v} - \frac{2}{3}\beta_2 \left(\frac{\lambda^3}{v}\right)^2,$$

where $\lambda[= h/\sqrt{(2\pi mkT)}]$ is the "mean thermal wavelength" of the particles while β_1 and β_2 are certain temperature-dependent coefficients.

Show that, at the critical point of this system,

$$(\beta_1)_c = \frac{2v_c}{\lambda_c^3} \quad \text{and} \quad (\beta_2)_c = -\frac{v_c^2}{2\lambda_c^6}.$$

In view of these results, show that the quantity RT_c/P_cv_c for this gas is equal to 3.