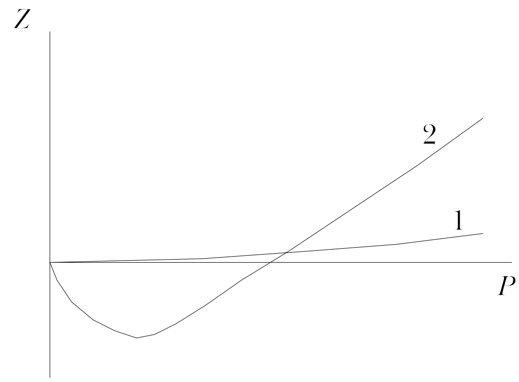
CHEM 441-02
College of Charleston
Fall 2001
Exam 1

Name ______________________________

Score ____________ / 125

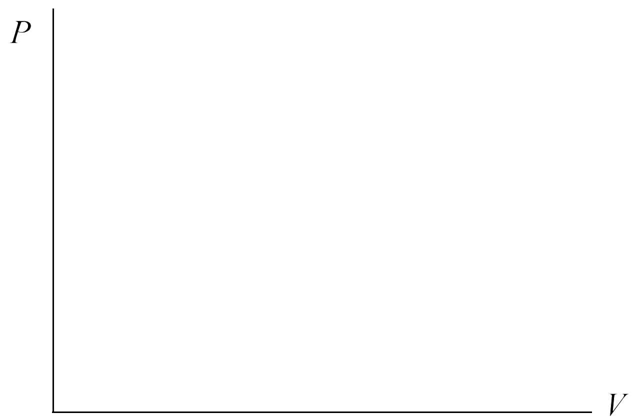
1(10). Consider the two isotherms shown on the compressibility plot shown at the right.



If the isotherms represent two different substances at the same temperature, which curve represents the substance with the greater intermolecular forces? _____

If the isotherms represent two different temperatures for the same substance, which curve represents the lower temperature? _____

2(15). On the axes provided, for a real gas sketch an isotherm at $T >> T_c$ and label it "A", at $T < T_c$ and label it "B", and at $T = T_c$ and label it "C". For the "B" isotherm also show the "cubic behavior" shown by several of the equations of state for real gases (e.g., the van der Waals equation) using a dashed line and label it "D".



3(15). Consider a 75.0-L tank containing 75.0 mol of nitrogen gas at 25 °C (a gas cylinder in the phy chem lab). Calculate the pressure of the gas using

A. the ideal gas law

B. the van der Waals equation (a = 1.3661 dm^6 bar mol^{-1}, b = 0.038577 dm^3 mol^{-1})

C. Describe the steps needed to use the compressibility factor Z if Z data are available on a plot like shown in question 1.

4(30). Calculate the ratio of the London dispersion forces to the total dipole forces in water at 25 °C. For water, $\mu = 6.14 \times 10^{-30}$ C m, $\alpha = 1.66 \times 10^{-40}$ C^2 J^{-1} m^2, $I = 2.02 \times 10^{-18}$ J.

5(30). Considering rotational, vibration, and translation contributions as being important to the heat capacity of gaseous water at 155 °C, calculate $C_{v,m}$. For water, θ_{vib}/(K) = 2290, 5160, 5360; θ_{rot}/(K) = 40.1, 20.9, 13.4; D_o = 917.6 kJ mol^{-1}.

6(25). The translation partition function for a particle moving through a nanotube is

$$q(a,T) = \left(\frac{2\pi m k_B T}{h^2}\right)^{1/2} a$$

where a is the length of the tube and $Q(N,a,T) = q(a,T)^N/N!$. Derive an expression for $\langle E_m \rangle$.

Derive an expression for $C_{v,m}$.