CHEM442-001/002 Name _______________________________
College of Charleston
Fall 2000
Exam II Score ___________ /100

1(10). The van der Waals constant *a* represents a correction to ideal gas behavior for ____________________________ and the constant *b* represents a correction for ____________________________. The van der Waals constants listed in the table correspond to gaseous C_6H_6, $C_6H_5CH_3$, Ne, and CH_3OH. Correctly identify each set of values with the respective gas by writing the formula of the gas in the first column.

gas	a/(L^2 atm mol^{-2})	b/(L mol^{-1})
	9.523	0.06702
	18.00	0.1154
	0.2107	0.01709
	24.06	0.1463

2(10). The van der Waals equation of state is a cubic equation in the amount of substance ("number of moles") *n*. Explain in words how the value of *n* can be evaluated correctly. Note: simply saying using the equation solver on a calculator or in a computer program like Mathcad or spreadsheet will not receive any credit.

3(60). The following (unnamed) equations of state for one mole of gas may be useful in this problem:

$$P = \frac{RT}{T}$$

$$P = \frac{RT}{V - b} - \frac{a}{T^{1/2}\, V(V + b)}$$

$$P = \frac{RT}{V - b}\, e^{-a/VRT}$$

$$P = \frac{RT}{V - b} - \frac{a}{V^2}$$

$$P = \frac{ZRT}{V} \quad (\textit{values of Z available on chart provided})$$

For a molar sample of steam occupying 30.16 L at exactly 100 ºC, calculate the pressure (watch significant figures) using

A. the ideal gas law

B. the van der Waals equation of state (a = 5.464 L^2 atm mol^{-2}, b = 0.03049 L mol^{-1})

C. the Dieterici equation of state (a = 7.011 L^2 atm mol^{-2}, b = 0.0330 L mol^{-1})

D. the law of corresponding states (T_c = 374 °C, P_c = 218.3 atm)

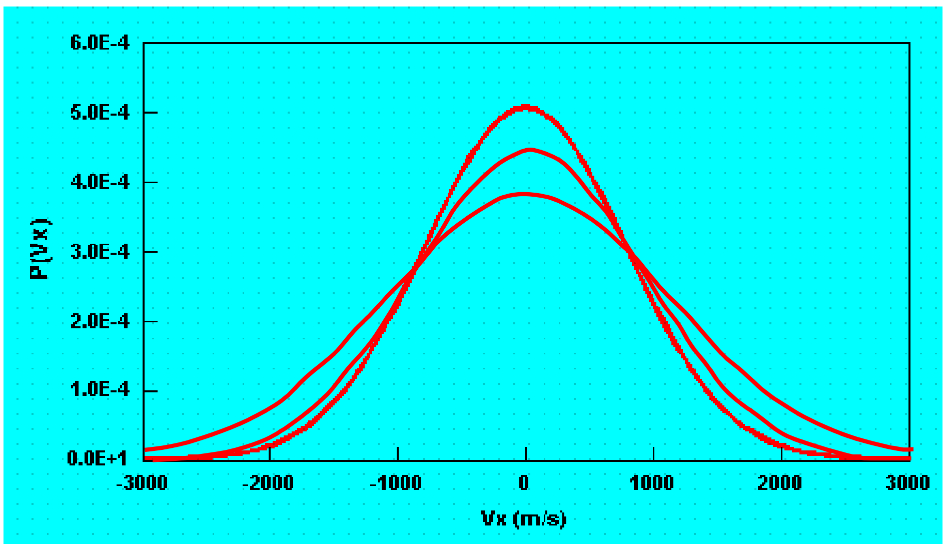
E. The actual value is P = 1.000 atm. Compare your answers from above to each other and to the actual value. Briefly discuss your results.

F. One homework problem (Barrow 1-29) used both the two-coefficient and the three-coefficient forms of the van der Waals equation to calculate the volume of steam at 373 K and 0.50 bar. The two-coefficient result gave a result near that of the ideal gas law and the three-coefficient form gave a value significantly different (~50 %). The answer book (which several students copied verbatim) stated "The first constants give good convergence to the ideal gas law, but water near it's (sic) boiling (sic) should not be ideal. The second function is closer to observed behavior." Based on your results from above, briefly discuss this quoted statement.

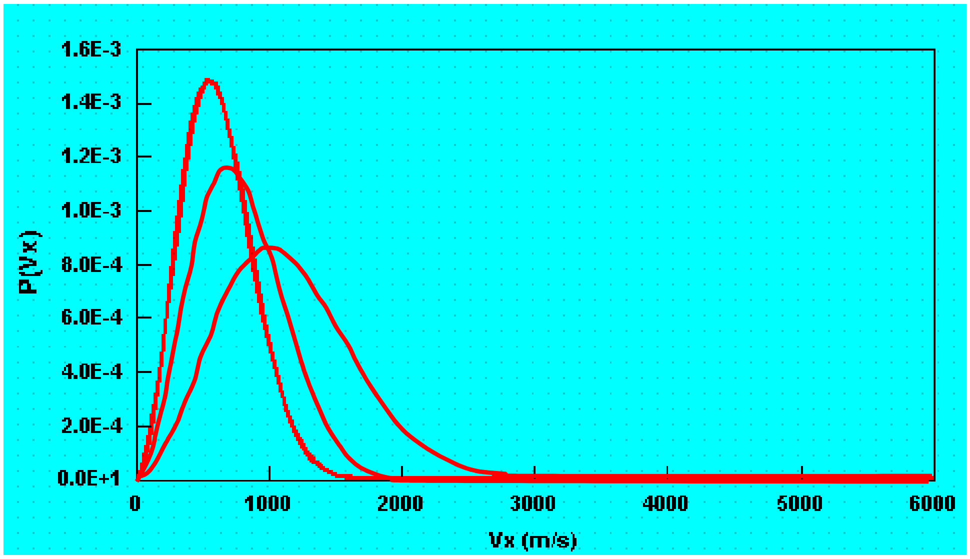
4(10). Calculate the pressure needed to confine 1.5×10^{25} gas molecules each with a mass of 1.5×10^{-25} kg and a root-mean-square speed of 1.5×10^3 m s^{-1} in a 1.5-m^3 container.

Calculate the temperature of the gas.

5(10). The following Maxwell plots are for H_2, HD, and D_2 all at the same temperature. Clearly identify which plot corresponds to which substance. Note: D is deuterium.



The following Maxwell-Boltzmann plots are for CH_4 at 300 K, 500 K, and 1000 K. Clearly identify which plot corresponds to which temperature.


1.6E-3
1.4E-3
1.2E-3
1.0E-3
8.0E-4
6.0E-4
4.0E-4
2.0E-4
0.0E+1
P(Vx)
0
1000
2000
3000
4000
5000
6000
Vx (m/s)