ChE 230
Summer 2003
Midterm Exam #1
Administered: Wednesday June, 18, 2003

A monatomic gas described by the ideal gas equation of state has a pressure and constant-pressure heat capacity given by

$$p = \frac{RT}{\underline{V}} \qquad \left(\frac{\partial \underline{H}}{\partial T}\right)_p \equiv \underline{C_p} = \frac{5}{2}R$$

A monatomic gas described by the van der Waals equation of state has a pressure and constant-pressure heat capacity given by

$$p = \frac{RT}{\underline{V} - b} - \frac{a}{\underline{V}^2} \qquad \left(\frac{\partial \underline{H}}{\partial T}\right)_p \equiv \underline{C_p} = \frac{R}{2}\left(\frac{5p\underline{V}^3 - \underline{V}a + 6ab}{p\underline{V}^3 - \underline{V}a + 2ab}\right)$$

R = 8.314 J/mole/K
1 atm = 101325 Pa

Problem 1.
We perform a Joule-Thomson experiment to measure the Joule-Thomson coefficient,
$\mu_{JT} \equiv \left(\frac{\partial T}{\partial p}\right)_{\underline{H}}$.

(a) Find an expression for the partial derivative representing the change in enthalpy per change in pressure under isothermal conditions for the ideal gas.
(b) Find an expression for the partial derivative representing the change in enthalpy per change in molar volume under isothermal conditions for the ideal gas.

Problem 2.
We have 2 moles of xenon (a monatomic gas) initially at T = 298 K and p = 1 atm.
The gas is heated at constant pressure to 600 K. Find the heat, work, change in molar internal energy, and change in molar enthalpy if we consider the material as an ideal gas.

Problem 3.
We have 2 moles of xenon (a monatomic gas) initially at T = 298 K and p = 1 atm.
(a) The gas is expanded at constant temperature to double the volume. Find the change in molar enthalpy if we consider the material as an ideal gas.
(b) Will we obtain the same result for a van der Waals equation of state? Why or why not?