Handin Homework 7

1. *Background*: The total differentials of U and H are:

$$dU = \left(\frac{\partial U}{\partial V}\right)_T dV + \left(\frac{\partial U}{\partial T}\right)_V dT \quad = \quad \left(\frac{\partial U}{\partial V}\right)_T dV + C_V\, dT$$

$$dH = \left(\frac{\partial H}{\partial P}\right)_T dP + \left(\frac{\partial H}{\partial T}\right)_P dT \quad = \quad \left(\frac{\partial H}{\partial P}\right)_T dP + C_P\, dT$$

This problem explores the relationship between the partials with respect to V and P.

Problem: Given that for an ideal gas $\left(\frac{\partial U}{\partial V}\right)_T = 0$, show that $\left(\frac{\partial H}{\partial P}\right)_T = 0$.

[Hint: for an ideal gas you can use PV = nRT][Try Chapter 9 Problems 7 and 12, first]

2. One mole of an ideal monatomic gas (C_V=3/2 nR) does –1000. J of work in a reversible expansion from 1.00 L initial volume and 10.0 atm initial pressure (that is, w = –1000. J). The process is at a constant temperature of 25.0°C. What is the final volume? [Try Chapter 9 Problem 21, first]

3. Repeat problem 2 but assume the process is a reversible <u>adiabatic</u> expansion from the same initial state. Note that the temperature will change in the process. What is the final temperature? What is the final volume? [Try Chapter 9 Problems 23 and 25, first]

4. This problem is the general version of Problem 1:

Show that: $\left(\frac{\partial H}{\partial P}\right)_T = \left(\frac{\partial U}{\partial V}\right)_T \left(\frac{\partial V}{\partial P}\right)_T + P \left(\frac{\partial V}{\partial P}\right)_T + V$

Show <u>all</u> your work with <u>reasons</u> for each step. For example: “since H is a state function,” “from the definition of heat capacity,” or “dividing by dP gives the desired result” are typical statements. If you use a partial derivative relationship that has a name, if you choose not to derive the relationship, just state the corresponding relationship name (e.g. “from the chain rule” or “from the Euler chain rule”).