

Handin Homework 7

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

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

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

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 remember that for an ideal gas you can also use $PV = nRT$]

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 $25.0^\circ C$. What is the final volume?

3. Repeat problem 2 but assume the process is a reversible adiabatic 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?

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

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

[Show all your work with reasons 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”)]