

## Handin Homework 7

1. Calculate  $q$ ,  $w$ ,  $\Delta U$ , and  $\Delta H$  for a reversible isothermal expansion of 2.00 mol of an ideal diatomic gas. The initial pressure is 20.00 bar, the final pressure is 1.00 bar, and the temperature is 298.2 K.

2. Calculate  $q$ ,  $w$ ,  $\Delta U$ , and  $\Delta H$  for a reversible adiabatic expansion of 2.00 mol of an ideal diatomic gas. The initial pressure is 20.00 bar, the final pressure is 1.00 bar, and the initial temperature is 298.2 K. Assume  $C_v = \frac{5}{2} nR$  (i.e. equipartition neglecting vibration). Compare the results with question 1.

3. *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: for an ideal gas you can also use  $PV = nRT$ ]

4. This problem is the general version of Problem 3:

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”)]