

Problems: Q3.8, Q3.10, P3.15, P3.18**, P3.26, P3.27**

HW3B

Due Tuesday (01/29/08)

**Problem has been modified, see below; P3.19 is listed below but not assigned; but it is an interesting problem.

Q3.8) What is the physical basis for the experimental result that U is a function of V at constant T for a real gas? Under what conditions will U decrease as V increases?

Q3.10) Can a gas be liquefied through an isoenthalpic expansion if $\mu_{J-T} = 0$?

P3.15) An 80.0-g piece of gold at 650 K is dropped into 100.0 g of $\text{H}_2\text{O}(l)$ at 298 K in an insulated container at 1 bar pressure. Calculate the temperature of the system once equilibrium has been reached. Assume that $C_{P,m}$ for Au and H_2O is constant at their values for 298 K throughout the temperature range of interest. **Carefully explain your starting formula on the basis of what the process changes are and the heat and work involved.

P3.18) Calculate w , q , ΔH , and ΔU for the process in which 1 mol of water undergoes the transition $\text{H}_2\text{O}(l, 373 \text{ K}) \rightarrow \text{H}_2\text{O}(g, 460 \text{ K})$ at 1 bar pressure. The volume of liquid water at 373 K is about 1 cc/gram or $18 \cdot 10^{-6} \text{ m}^3/\text{mole}$ and the volume of steam at 373 and 460 K is 3.0 and $3.7 \times 10^{-2} \text{ m}^3 \text{ mol}^{-1}$, respectively. For steam, $C_{P,m}$ can be considered constant over the temperature interval of interest at $33.58 \text{ J mol}^{-1} \text{ K}^{-1}$. The enthalpy (or heat) of vaporization of water at its boiling point is 40 kJ/mole. Clearly identify the process at the start of the problem.

P3.19) Because $\left(\frac{\partial H}{\partial P}\right)_T = -C_P \mu_{J-T}$, the change in enthalpy of a gas expanded at constant temperature can be calculated. In order to do so, the functional dependence of μ_{J-T} on P must be known. Treating Ar as a van der Waals gas, calculate ΔH when 1 mol of Ar is expanded from 400 bar to 1.00 bar at 300 K. Assume that μ_{J-T} is independent of pressure and is given by $\mu_{J-T} = \left(\frac{2a}{RT} - b\right)/C_{P,m}$ and $C_{P,m} = 5/2R$ for Ar treated as a vdW Gas..

b) What value would ΔH have if the gas exhibited ideal gas behavior?

P3.26) Derive the following expression for calculating the isothermal change in the constant volume heat capacity: $\left(\frac{\partial C_V}{\partial V}\right)_T = T\left(\frac{\partial^2 P}{\partial T^2}\right)_V$.

P3.27) Use the result of the Problem P3.26 to show that $\left(\frac{\partial C_V}{\partial V}\right)_T$ for the van der Waals gas is zero.