Chemistry 230
Problem Set # 9 — 10/27/99

Recommended Problems: Chapt. 7: 1-15, 21, 22, 24, 28, 31, 35-38, 42

1. Problem 7.25 in Levine. (d) Is there any indication of a temperature dependence in $\Delta H_{m,vap}$ over this temperature range? Explain.

2. Using your results from the preceding problem, calculate ΔH°_m, ΔG°_m, and ΔS°_m for the vaporization of Hg at 100.0˚C. (Treat the vapor as ideal. For the liquid, the molar volume and α can be obtained from information given in problem 4.15 in Levine.)

3. The heat of fusion of Hg at its normal melting point, –38.9˚C, is 2.82 cal/g. The densities of Hg(*s*) and Hg(*l*) at the normal melting point are 14.193 and 13.690 g/cm^3, respectively. Estimate the melting point of Hg at (a) 65 atm, and (b) 465 atm.

4. The vapor pressure of ethanol (C_2H_5OH) is 40.0 torr at 19.0˚C. (a) 1.99 g of ethanol is placed in an 11.1-L vessel at 19.0˚C. State what phase(s) are present at equlibrium and calculate the amounts (masses) of ethanol present in each phase. (b) Repeat the calculation for a vessel having a volume of 21.1 L.

5. At 293 K the vapor pressure of $I_2(s)$ is 0.25 torr and its density is 4.93 g/cm^3. Use the "Gibbs equation" to estimate the vapor pressure of iodine under a 1.00×10^3-atm pressure of Ar. [**Hint :** See Problem 7.43 in Levine.]

6. From the following data, sketch the phase diagram of nitrogen at low *T*. There are three crystal forms — α, β, and γ — which coexist at 4650 atm and 44.5 K. At this triple point, the volume changes ΔV_m (in cm^3/mol) are 0.165 ($\gamma \rightarrow \alpha$), 0.208 ($\gamma \rightarrow \beta$), and 0.043 ($\alpha \rightarrow \beta$). At 1.0 atm and 36 K, $\alpha \rightarrow \beta$ with ΔV_m = 0.22 cm^3/mol. The ΔS_m values for the cited transitions are 1.25, 5.88, 4.59, and 6.52 J K^{-1} mol^{-1}, respectively. [**Hint:** See J. Swenson, J. Chem. Phys. 23, 1963 (1955).]

7. Here is another variation on the theme we have visited several times already: the conversion of supercooled water to ice (or vice versa — see problems 6 & 7 on PS 5 and 3b on PS 6). At –10.0˚C the vapor pressure of ice is 1.950 torr and that of supercooled water is 2.149 torr. Our previous results at this temperature yielded for the molar heat of fusion (at *P* = 1.00 atm), $\Delta H_{fus,m}$ = 5.62 kJ/mol. Use this information to evaluate ΔG_m and ΔS_m for the process *water* → *ice* at –10.0˚C and 1.00 atm. Compare your results with those obtained in problems 6 on PS 5 and 3b on PS 6 (converted to molar quantities). Based on your results, should this process occur spontaneously?