Chemistry 230
Problem Set # 7 — 10/11/99

Recommended Problems: Chapt. 5: 2, 3, 10, 12, 13, 17, 26, 29, 40, 49, 52

1. Tungsten carbide is burned in excess O_2 in a bomb calorimeter, where it undergoes the reaction,

$$WC(s) + {}^5/_2\, O_2 \rightarrow WO_3(s) + CO_2\ .$$

It is found that $\Delta U°$ for this reaction at 300 K is –1192 kJ/mol. Calculate $\Delta H°_{300}$.

Given that the heats of combustion of C(*graphite*) and W(*s*) at 1.00 bar and 300 K are –393.5 and –837.5 kJ/mol, respectively, calculate $\Delta H°_{f,300}$ for WC(*s*).

2. Problem 5.19 in Levine. Also calculate $S°_{m,1000}$, $\Delta S°_{f,1000}$, and $\Delta G°_{f,1000}$.

3. Heat capacity data have been obtained for triptycene ($C_{20}H_{14}$) between 10.0 K and 527.18 K for solid, and between 527.18 K and 550.0 K for liquid. [The data are available in tabular form at 28 temperatures in this range and can be obtained by copying the following CTRVAX file into your account: PUB6:[TELLINJB]TRIP.DAT. They are also available on the course web site, at the following URL: `http://www.vanderbilt.edu/AnS/Chemistry/Tellinghuisen/Chem230/TRIP.DAT.`] The compound melts at 527.18 K with $\Delta H°_{fus,m}$ = 7236 cal/mol. Use numerical integration to evaluate (a) $S°_{m,298}$ for $C_{20}H_{14}(s)$; (b) $S°_{m,550}$ for $C_{20}H_{14}(l)$; (c) $H°_{m,298} - H°_{m,0}$. [**Hint:** See Problem 5.22 for a review of the trapezoidal rule and Problem 5.23 for its application to a situation just like the present one. You may also find it convenient to use the "Integrate" Macro in KaleidaGraph.]

4. Problems 5.5 and 5.27 in Levine. Use these results to calculate $\Delta G°_{298}$ for each reaction, and compare the results with those obtained using the $\Delta G°_{f,298}$ values given in the Appendix.

5. Some values for $(H°_{m,1500} - H°_{m,298})$ (in kcal/mol) are 9.706 for $O_2(g)$, 9.179 for $N_2(g)$, and 14.176 for $NO_2(g)$. Use these data with Appendix data to find $\Delta H°_{f,1500}$ for $NO_2(g)$.

For T = 1500 K, some values of the "free energy function," $-(G°_{m,T} - H°_{m,298})/T$, in cal/(mol K), are 55.185 for $O_2(g)$, 51.665 for $N_2(g)$, and 65.982 for $NO_2(g)$. Use these data along with Appendix data to determine $\Delta G°_{f,1500}$ for $NO_2(g)$. [**Hint:** See problems 5.37 and 5.38 in Levine.]