

Chemistry 230
Problem Set # 7 -- Answers

1. $H^\circ = U^\circ + (PV) = U^\circ + (n)RT = U^\circ - 3/2RT = -1196 \text{ kJ/mol.}$
 $H^\circ_{\text{rx}} = H_f^\circ(\text{WO}_3) + H_f^\circ(\text{CO}_2) - H_f^\circ(\text{WC}) = H^\circ_{\text{comb}}(\text{W}) + H^\circ_{\text{comb}}(\text{C}) - H_f^\circ(\text{WC})$
 $H_f^\circ(\text{WC}) = -35 \text{ kJ/mol.}$

2. $H_{f,1000}^\circ = H_{f,298}^\circ + \int_{298}^{1000} C_P^\circ dT \quad H_{f,1000}^\circ[\text{HCl}(g)] = -94.385 \text{ kJ/mol.}$
 $S_{m,1000}^\circ = S_{m,298}^\circ + \int_{298}^{1000} \frac{C_{P,m}^\circ}{T} dT \quad S_{m,1000}^\circ[\text{HCl}(g)] = 222.797 \text{ J mol}^{-1} \text{ K}^{-1}$
 $S_{m,1000}^\circ[\text{Cl}_2(g)] = 266.443 \text{ J mol}^{-1} \text{ K}^{-1}; S_{m,1000}^\circ[\text{H}_2(g)] = 166.245 \text{ J mol}^{-1} \text{ K}^{-1.}$
 $S_{f,1000}^\circ = \quad i S_{m,i,1000}^\circ = S_{f,298}^\circ + \int_{298}^{1000} \frac{C_{P,m}^\circ}{T} dT = 6.454 \text{ J mol}^{-1} \text{ K}^{-1.}$
 $G_{f,1000}^\circ = H_{f,1000}^\circ - T S_{f,1000}^\circ = -100.839 \text{ kJ/mol.}$

3. To carry out the numerical integrations, you might try, for example, the "Integrate-Area" command under the **Macros** menu in KaleidaGraph. To get the contribution for $T < 10 \text{ K}$, see p. 150 of Levine.
 (a) $S_{m,298}^\circ = 65.366 \text{ cal mol}^{-1} \text{ K}^{-1}$. (The numerically integrated contribution above 10K is 65.078.)
 (b) $S_{m,550}^\circ = 137.28 \text{ cal mol}^{-1} \text{ K}^{-1}$.
 (c) $H_{m,298}^\circ - H_{m,0}^\circ = 9911 \text{ cal/mol.}$

4. (a) $G_{298}^\circ = -1007.56 \text{ vs } -1007.53 \text{ kJ/mol.}$
 (b) $G_{298}^\circ = -990.45 \text{ vs } -990.41 \text{ kJ/mol.}$
 (c) $G_{298}^\circ = -949.50 \text{ vs } -949.65 \text{ kJ/mol.}$

5. (a) $H_{f,1500}^\circ = 32.68 \text{ kJ/mol.}$ (b) $G_{f,1500}^\circ = 30.483 \text{ kcal/mol.}$