

Homework #7

1. The molar enthalpy of vaporization of benzene at its normal boiling point (80.09 °C) is 30.72 kJ/mol. Assuming that $\Delta_{\text{vap}} \bar{H}$ and $\Delta_{\text{vap}} \bar{S}$ are temperature independent, calculate the values of $\Delta_{\text{vap}} \bar{G}$ at 75 °C and 85.0 °C. Explain your results.
2. What are the natural variables of entropy? Explain your answers briefly.
3. Starting from $dU = TdS - PdV$ derive the Maxwell relation below:

$$\left(\frac{\partial T}{\partial V} \right)_S = - \left(\frac{\partial P}{\partial S} \right)_V$$

4. How much energy is available for sustaining muscular and nervous activity from the combustion of 1.00 mol of glucose molecules under standard conditions at 37 °C (i.e., body temperature)? The standard entropy of reaction is $182.4 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$ and the standard enthalpy of reaction is $-2808 \text{ kJ} \cdot \text{mol}^{-1}$. How is this related to the maximum non-PV work?
5. Calculate $\Delta_r G(375\text{K})$ for the reaction $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g})$ from the appropriate values of $\Delta_r G(298\text{K})$, $\Delta_r H(298\text{K})$, and the Gibbs-Helmholtz equation. Info you may need: $\Delta_f H(298\text{K})$: $\text{CO} = -110.53 \text{ kJ} \cdot \text{mol}^{-1}$ and $\text{CO}_2 = -393.51 \text{ kJ} \cdot \text{mol}^{-1}$. $\Delta_f S(298\text{K})$: $\text{CO} = 197.66 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$, $\text{O}_2 = 205.07 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$, and $\text{CO}_2 = 213.79 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$.
6. a) When 2 moles of gas at 330 K and 3.50 atm is subjected to isothermal compression, the entropy drops by 25.0 J/K. Find the final pressure and Gibbs free energy. Assume a monatomic, ideal gas.
b) Repeat the calculation for an adiabatic compression.