1. Explain the following terms:
   (1) Ideal Gas Law (2) the Second Law of Thermodynamics
   (3) Colligative Properties (4) Ideal Solution (5) Faraday’s Law of Electrolysis  
   (10 points)

2. A balloon filled with 10.50 L of Ar at 18.0°C and 1 atm rises to a height in the atmosphere where the pressure is 248 Torr and the temperature is −30.5°C. What is the final volume of the balloon? Assume ideal behavior for the Ar gas. (10 points)

3. An ideal mono-atomic gas undergoes the following sequence processes (a) 70°C, 1 bar, reversible adiabatic compressing to to P=1.689 bar(b) then at constant pressure cooling to T=70°C (c) then, reversible isothermal expanding to return the initial state. Depict this closed-cycle process in a P-V diagram and calculate w (work), q (heat), ΔU (internal energy), and ΔH (enthalpy) for the total process. (10 points)

4. The bubble point of water at one atmosphere is 100°C. The enthalpy evaporation at that condition is 2257 J/g. Please estimate q, w, ΔU, ΔS (entropy), and ΔG (free energy) of evaporation of one mole water at 1 atm and 100°C. (10 points)

5. You have containers of pure H₂ and He at 298 K and 1 atm pressure. Calculate ΔS_{mixing}, and ΔG_{mixing} for a mixture of 10 mol of H₂ and 10 mol of He. Assume ideal behavior for the mixing system. (10 points)
6. You have collected a tissue specimen that you would like to preserve by freeze drying. To ensure the integrity of the specimen, the temperature should not exceed \(-10.5^\circ C\). The vapor pressure of ice at 273.16 K is 611 Pa; \(\Delta H_{\text{fusion}}^* = 6.01 \text{ kJ mol}^{-1}\) and \(\Delta H_{\text{vaporation}}^* = 40.65 \text{ kJ mol}^{-1}\). What is the maximum pressure at which the freeze drying can be carried out? \((10 \text{ points})\)

7. At 303 K, the vapor pressure of benzene is 118 Torr and that of cyclohexane is 122 Torr. Calculate the vapor pressure of a solution for which \(x_{\text{benzene}} = 0.25\), assuming the solution is an ideal mixing. \((10 \text{ points})\)

8. The standard potential \(E^0\) for a given cell is 1.100 V at 298.15 K and

\[ (\partial E^0/\partial T)_P = -6.5 \times 10^{-5} \text{ V/K}. \]

Calculate \(\Delta E_{\text{cell}}\), \(K_{\text{eq}}\) (at equilibrium state), \(\Delta G_{\text{reaction}}^*\), \(\Delta S_{\text{reaction}}^*\), and \(\Delta H_{\text{reaction}}^*\).

Assume that \(n = 2\). \((10 \text{ points})\)

9. Consider the schematic reaction \(A \rightarrow^k P\). \((10 \text{ points})\)

   a. If the reaction is the first order with respect to \([A]\), what are the integrated rate law expression and the half-life for this reaction?

   b. If the rate constant for the reaction is \(2.48 \times 10^{-4} \text{ s}^{-1}\). What is the half-life for first order reaction?

10. For the sequential reaction \(A \rightarrow^k B \rightarrow^k C\), the rate constants are \(k_a = 5 \times 10^6 \text{ s}^{-1}\) and \(k_b = 3 \times 10^6 \text{ s}^{-1}\). Determine the time and the concentration of \([B]\) at which \([B]\) is at a maximum. \((10 \text{ points})\)