1. Assign oxidation numbers to all of the underlined atoms in each of the following.
   a. HNO₃
   b. Na₂C₂O₄
   c. (NH₄)Ce(SO₄)₃
   d. Ce₂O₃

2. For each of the following equations:
   a. Balance by the half-reaction method for the pH conditions specified.
   b. Indicate the oxidizing agent, the reducing agent, the species oxidized, and the species reduced.

   a. Al(s) + MnO₄⁻(aq) → Al³⁺(aq) + Mn²⁺(aq) (acidic solution)

   b. PO₃⁻₅(aq) + MnO₄⁻(aq) → PO₄³⁻(aq) + MnO₂(s) (basic solution)

3. For the skeleton reaction: IO₃⁻(aq) + Fe²⁺(aq) → Fe³⁺(aq) + I₂(s)
   a. Sketch the galvanic cell. Show the direction of electron flow and of ion migration through the salt bridge.
   b. Identify the cathode and the anode.
   c. Calculate the $E^{\circ}$ value for the cell. Assume all concentrations are 1.0 M and all partial pressures are 1.0 atm.
   d. Give the overall balanced reaction.

4. In acidic solution, ozone and manganese(II) react spontaneously according to the following skeleton reaction:
   $\text{O}_3(g) + \text{Mn}^{2+}(aq) \rightarrow \text{O}_2(g) + \text{MnO}_2(s)$
   a. Write the half-reactions for oxidation and reduction.
   b. Write the overall balanced redox reaction.
   c. If $E^{\circ}_{\text{cell}} = +0.84 \text{ V}$ and $E^{\circ}_{\text{ozone}} = +2.07 \text{ V}$, calculate $E^{\circ}_{\text{Mn}^{2+}/\text{Mn}}$.
5. A voltaic cell consists of a Mn/Mn\(^{2+}\) half-cell and a Pb/Pb\(^{2+}\) half-cell. Calculate \([\text{Pb}^{2+}]\) when \([\text{Mn}^{2+}] = 1.3 \text{ M}\) and \(E_{\text{cell}} = 0.42 \text{ V}\).

6. Given the reactions:
   \[
   \begin{align*}
   \text{Ag(s)} & \rightarrow \text{Ag}^{+} \text{(aq)} + e^- & E^{0}_{\text{ox}} = -0.80 \text{ V} \\
   \text{AgCl(s)} + e^- & \rightarrow \text{Ag(s)} + \text{Cl}^{-} \text{(aq)} & E^{0}_{\text{red}} = +0.22 \text{ V}
   \end{align*}
   \]
   Calculate \(K_{\text{sp}}\) of AgCl.

7. For Ni(s) and Ag\(^{+}\)\text{(aq)}
   a. Calculate the value of the equilibrium constant at 25°C.
   b. Calculate \(\Delta G^{0}\).

8. A concentration cell consists of two Sn/Sn\(^{2+}\) half-cells. The electrolyte in compartment A is 0.13 M Sn(NO\(_3\))\(_2\); in compartment B, it is 0.87 M Sn(NO\(_3\))\(_2\).
   a. Which compartment houses the cathode?
   b. Calculate the voltage of the cell.