2. Answer the following questions that relate to electrochemical reactions.

(a) Under standard conditions at 25°C, Zn(s) reacts with Co^{2+}(aq) to produce Co(s).
   (i) Write the balanced equation for the oxidation half reaction.
   (ii) Write the balanced net-ionic equation for the overall reaction.
   (iii) Calculate the standard potential, $E^0$, for the overall reaction at 25°C.

(b) At 25°C, $\text{H}_2\text{O}_2$ decomposes according to the following equation:

$$2\text{H}_2\text{O}_2(aq) \rightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g) \quad E^0 = 0.55 \text{ V}$$

   (i) Determine the value of the standard free energy change, $\Delta G^0$, for the reaction at 25°C.
   (ii) Determine the value of the equilibrium constant, $K_{eq}$, for the reaction at 25°C.
   (iii) The standard reduction potential, $E^0$, for the half reaction $\text{O}_2(g) + 4 \text{H}^+(aq) + 4e^- \rightarrow 2 \text{H}_2\text{O}(l)$ has a value of 1.23 V. Using this information in addition to the information given above, determine the value of the standard reduction potential, $E^0$, for the half reaction below.

$$\text{O}_2(g) + 2 \text{H}^+(aq) + 2e^- \rightarrow \text{H}_2\text{O}_2(aq)$$

(c) In an electrolytic cell, Cu(s) is produced by the electrolysis of CuSO$_4$(aq). Calculate the maximum mass of Cu(s) that can be deposited by a direct current of 100 amperes passed through 5.00 L of 2.00 M CuSO$_4$(aq) for a period of 1.00 hour.