1) Explain each of the following.

(a) When an aqueous solution of NaCl is electrolyzed, $Cl_2(g)$ is produced at the anode, but no Na(s) is produced at the cathode.

(b) The mass of Fe(s) produced when 1 faraday is used to reduce a solution of $FeSO_4$ is 1.5 times the mass of Fe (s) produced when 1 faraday is used to reduce a solution of $FeCl_3$.

$$Zn + Pb^{2+}\ (1\text{-molar}) \text{---> } Zn^{2+}\ (1\text{-molar}) + Pb$$

(c) The cell that utilized the reaction above has a higher potential when $[Zn^{2+}]$ is decreased and $[Pb^{2+}]$ held constant, but a lower potential when $[Pb^{2+}]$ is decreased and $[Zn^{2+}]$ is held constant.

(d) The cell that utilizes the reaction given in (c) has the same cell potential as another cell in which $[Zn^{2+}]$ and $[Pb^{2+}]$ are each 0.1-molar.

2) An unknown metal M forms a soluble compound $M(NO_3)_2$.

(a) A solution of $M(NO_3)_2$ is electrolyzed. When a constant current of 2.50 amperes is applied for 35.0 minutes, 3.06 grams of the metal M is deposited. Calculate the molar mass of M and identify the metal.

(b) The metal identified in (a) is used with zinc to construct a galvanic cell, as shown below. Write the net ionic equation for the cell reaction and calculate the cell potential, E°.

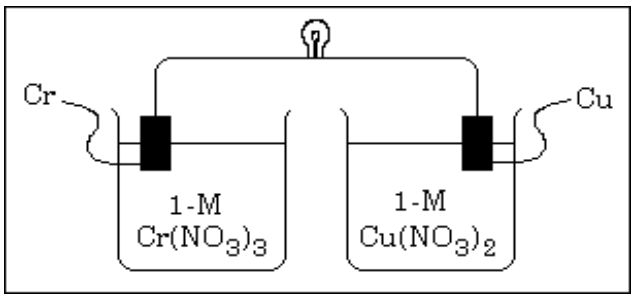
(c) Calculate the value of the standard free energy change, ΔG°, at 25 °C for the reaction in (b)

(d) Calculate the potential, E, for the cell shown in (b) if the initial concentration of $ZnSO_4$ is 0.10-molar, but the concentration of the $M(NO_3)_2$ solution remains unchanged.

3) A galvanic cell is constructed using a chromium electrode in a 1.00 molar solution of $Cr(NO_3)_3$ and a copper electrode in a 1.00 molar solution of $Cu(NO_3)_2$. Both solutions are at 25°C.

(a) Write a balanced net ionic equation for the spontaneous reaction that occurs as the cell operates. Identify the oxidizing agent and the reducing agent.

(b) A partial diagram of the cell is shown below.



(i) Which metal is the cathode?

(ii) What additional component is necessary to make the cell operate?

(iii) What function does the component in (ii) serve?

(c) How does the potential of this cell change if the concentration of $Cr(NO_3)_3$ is changed to 3.00 molar at 25 °C? Explain.

4) $Sr(s) + Mg^{2+} <===> Sr^{2+} + Mg(s)$

Consider the reaction represented above that occurs at 25°C. All reactants and products are in their standard states. The value of the equilibrium constant, K_{eq}, for the reaction is 4.2×10^{17} at 25°C.

(a) Predict the sign of the standard cell potential, E°, for a cell based on the reaction. Explain your prediction.

(b) Identify the oxidizing agent for the spontaneous reaction.

(c) If the reaction were carried out at 60°C instead of 25°C, how would the cell potential change? Justify your answer.

(d) How would the cell potential change if the reaction were carried out at 25°C with a 1.0-molar solution of $Mg(NO_3)_2$ and a 0.10-molar solution of $Sr(NO_3)_2$? Explain.

(e) When the cell reaction in (d) reaches equilibrium, what is the cell potential?

5) In an electrolytic cell, a current of 0.250 ampere is passed through a solution of a chloride of iron, producing Fe(s) and $Cl_2(g)$.

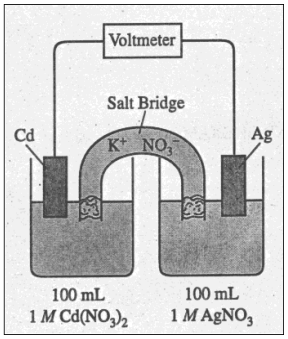
a) Write the equation for the reaction that occurs at the anode.

b) When the cell operates for 2.00 hours, 0.521 gram of iron is deposited at one electrode. Determine the formula of the chloride of iron in the original solution.

c) Write the balanced equation for the overall reaction that occurs in the cell.

d) How many liters of $Cl_2(g)$, measured at 25 °C and 750 mmHg, are produced when the cell operates as described in part (b)?

e) Calculate the current that would produce chlorine gas at a rate of 3.00 grams per hour.

6) 

Answer the following questions regarding the electrochemical cell shown above.

(a) Write the balanced net-ionic equation for the spontaneous reaction that occurs as the cell operates, and determine the cell voltage.

(b) In which direction do anions flow in the salt bridge as the cell operates? Justify your answer.

(c) If 10.0 mL of 3.0-molar $AgNO_3$ solution is added to the half-cell on the right, what will happen to the cell voltage? Explain.

(d) If 1.0 grams of solid NaCl is added to each half-cell, what will happen to the cell voltage? Explain.

(e) If 20.0 mL of distilled water is added to both half-cells, the cell voltage decreases. Explain.