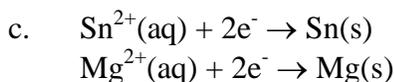


21 • Electron Transfer Reactions

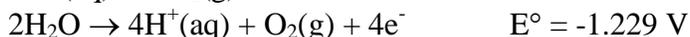
STUDY QUESTIONS

- Write equations for the reaction between iron and a solution of silver nitrate to produce Fe^{2+} ions and silver metal:
 - write the balanced half-cell reactions
 - write the overall balanced equation for the reaction
 - draw a diagram of the cell and calculate the standard cell potential
- Write equations for the reaction between manganese(IV) dioxide and the hypochlorite ion to produce the permanganate ion and the chloride ion in basic solution:
 - write the balanced half-cell reactions
 - write the overall balanced equation for the reaction
 - draw a diagram of the cell and calculate the standard cell potential
- The following reaction occurs in acidic solution. Balance the equation according to the general procedure outlined in the margin, describing each step of the process in turn:
$$\text{Fe}^{3+}(\text{aq}) + \text{NH}_3\text{OH}^+(\text{aq}) \rightarrow \text{N}_2\text{O}(\text{g}) + \text{Fe}^{2+}(\text{aq})$$
- Balance the following reactions in acidic solution:
 - $\text{Al}(\text{s}) + \text{Ag}^+(\text{aq}) \rightarrow \text{Al}^{3+}(\text{aq}) + \text{Ag}(\text{s})$
 - $\text{Fe}^{2+}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{Fe}^{3+}(\text{aq})$
 - $\text{MnO}_4^-(\text{aq}) + \text{H}_2\text{SO}_3(\text{aq}) \rightarrow \text{Mn}^{2+} + \text{SO}_4^{2-}(\text{aq})$
- Balance the following reactions in basic solution:
 - $\text{AsO}_2^-(\text{aq}) + \text{ClO}^-(\text{aq}) \rightarrow \text{AsO}_3^-(\text{aq}) + \text{Cl}^-(\text{aq})$
 - $\text{MnO}_4^-(\text{aq}) + \text{C}_2\text{O}_4^{2-}(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + \text{CO}_3^{2-}(\text{aq})$
 - $\text{N}_2\text{H}_4(\text{aq}) + \text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + \text{H}_2\text{O}_2(\text{aq})$
- Consider the following pairs of half-reactions, decide which of the two half-reactions will occur at the anode and which will occur at the cathode, draw diagrams for the cells, and calculate the standard cell potentials:
 - $\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Co}(\text{s})$
 $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$
 - $\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s})$
 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$



7. Examine a table of standard electrode reduction potentials and determine whether the following statements are true or false.
- Magnesium will react with water to produce hydrogen gas.
 - A piece of nickel immersed in a solution of silver nitrate will become coated with silver.
 - In basic solution, manganese dioxide will oxidize mercury to mercury(II) oxide.
 - The iodate ion in acidic solution will oxidize copper metal.
 - Nitric acid will oxidize tin to Sn^{2+} , producing nitric oxide, NO.
8. The reaction of copper metal with silver ions in a solution of silver nitrate is spontaneous. Calculate the standard cell potential to show that this is so. From the cell potential calculate the value of the equilibrium constant for the reaction at 25°C . From the equilibrium constant, or the reaction, calculate the standard free energy change for the reaction. Indicate clearly how these three quantities are related.
9. A copper-zinc voltaic cell is constructed using 100 mL solutions of 1M solutions of copper sulfate and zinc sulfate with a sodium sulfate salt bridge. After some time, t , had passed at 25°C , the concentration of the Zn^{2+} ions in the anode half cell had increased to 1.50M and the concentration of the Cu^{2+} ions in the cathode half-cell had decreased to .50 M
- Calculate the initial cell potential
 - Calculate the cell potential at time, t .
 - Calculate the total charge provided by the cell.
 - Calculate (approx.) the energy provided by the cell.

10. Possible anode reactions in the electrolysis of seawater are:



Possible cathode reactions in the electrolysis of sea water are:



Which two half-reactions will occur when seawater is electrolyzed?

11. If the solution of the salt in the cell described in question 10 is saturated, chlorine is produced at the anode instead of oxygen. Using an applied potential of 5.0V to overcome kinetic effects, and a current of quarter million amps,
- how long would it take to produce 1000 kg of chlorine gas?
 - how much sodium hydroxide would also be produced?
 - how much energy would be used in the process?