

Chapter 18 problems (without solutions)

- 1) Assign oxidation numbers for the following species (for review see section 9.4)
 - a) H_2SO_3
 - b) $\text{Ca}(\text{ClO}_3)_2$
 - c) C_2H_4
 - d) H_3PO_4
 - e) Cl_2
 - f) BrO_4^-
 - g) KMnO_4
 - h) NaOH
 - i) H_2O_2
 - j) $\text{H}_4\text{P}_2\text{O}_7$
- 2) Balance each redox reaction occurring in acid aqueous solution.
 - a) $\text{I}^-(\text{aq}) + \text{NO}_2^-(\text{aq}) \rightarrow \text{I}_2(\text{s}) + \text{NO}(\text{g})$
 - b) $\text{NO}_3^-(\text{aq}) + \text{Sn}^{2+}(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + \text{NO}(\text{g})$
 - c) $\text{S}_2\text{O}_3^{2-}(\text{aq}) + \text{I}_2(\text{aq}) \rightarrow \text{S}_4\text{O}_6^{2-}(\text{aq}) + \text{I}^-(\text{aq})$
- 3) Balance each redox reaction occurring in base aqueous solution.
 - a) $\text{MnO}_4^-(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + \text{BrO}_3^-(\text{aq})$
 - b) $\text{NO}_2^-(\text{aq}) + \text{Al}(\text{s}) \rightarrow \text{NH}_3(\text{g}) + \text{AlO}_2^-(\text{aq})$
- 4) (18.2 a,c) Balance the following redox reactions by the half-reaction method.
 - a) $\text{Mn}^{2+}(\text{aq}) + \text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + \text{H}_2\text{O}(\ell)$ (in base solution)
 - c) $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{C}_2\text{O}_4^{2-}(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{CO}_2(\text{g})$ (in acid solution)
- 5) Explain the difference between a voltaic (or galvanic) electrochemical cell and an electrolytic one.
- 6) Explain the purpose of a salt bridge in an electrochemical cell.
- 7) How can Table 18.1 be used to predict whether or not a metal will dissolve in HCl ? In HNO_3 ?
- 8) Give the half cell oxidation reaction, the half cell reduction reaction, and the net cell reaction for the following galvanic cells.
 - a) $\text{Pb}(\text{s}) \mid \text{Pb}^{2+}(\text{aq}) \parallel \text{Cu}^{2+}(\text{aq}) \mid \text{Cu}(\text{s})$
 - b) $\text{Pt}, \text{H}_2(\text{g}) \mid \text{H}^+(\text{aq}) \parallel \text{Cl}^-(\text{aq}) \mid \text{AgCl}(\text{s}), \text{Ag}(\text{s})$
- 9) Calculate the standard cell potential for each of the following electrochemical cells. Also, represent each cell as a cell diagram using standard notation.
 - a) $\text{Ni}^{2+}(\text{aq}) + \text{Mg}(\text{s}) \rightarrow \text{Ni}(\text{s}) + \text{Mg}^{2+}(\text{aq})$
 - b) $2 \text{H}^+(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{H}_2(\text{g}) + \text{Fe}^{2+}(\text{aq})$
 - c) $2 \text{NO}_3^-(\text{aq}) + 8 \text{H}^+(\text{aq}) + 3 \text{Cu}(\text{s}) \rightarrow 2 \text{NO}(\text{g}) + 4 \text{H}_2\text{O}(\ell) + 3 \text{Cu}^{2+}(\text{aq})$
- 10) Which of the redox reactions do you expect to occur spontaneously in the forward direction (for standard conditions)?
 - a) $\text{Ni}(\text{s}) + \text{Zn}^{2+}(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + \text{Zn}(\text{s})$
 - b) $\text{Ni}(\text{s}) + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + \text{Pb}(\text{s})$
 - c) $\text{Al}(\text{s}) + 3 \text{Ag}^+(\text{aq}) \rightarrow \text{Al}^{3+}(\text{aq}) + 3 \text{Ag}(\text{s})$
 - d) $\text{Pb}(\text{s}) + \text{Mn}^{2+}(\text{aq}) \rightarrow \text{Pb}^{2+}(\text{aq}) + \text{Mn}(\text{s})$

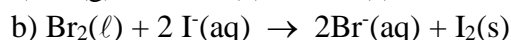
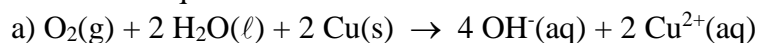
11) Which metal cation is the best oxidizing agent?

- a) Pb^{2+} b) Cr^{3+} c) Fe^{3+} d) Sn^{2+}

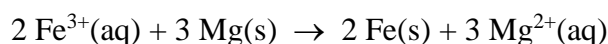
12) Which metal is the best reducing agent?

- a) Mn b) Al c) Ni d) Cr

13) Use tabulated electrode potentials to calculate $\Delta G^\circ_{\text{rxn}}$ for each reaction at 25. °C. Then calculate the equilibrium constant for each reaction.



14) A voltaic cell employs the redox reaction



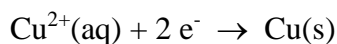
Calculate the cell potential at 25. °C under each set of conditions

a) Standard conditions. We first need to find E°_{net} .

b) $[\text{Fe}^{3+}] = 1.0 \times 10^{-3} \text{ M}$; $[\text{Mg}^{2+}] = 2.50 \text{ M}$

c) $[\text{Fe}^{3+}] = 2.00 \text{ M}$; $[\text{Mg}^{2+}] = 1.5 \times 10^{-3} \text{ M}$

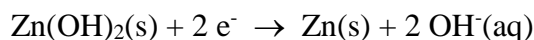
15) Copper can be electroplated at the cathode of an electrolytic cell by the half reaction



How much time would it take for 325. mg of copper metal to be plated at a current of 5.6 A?

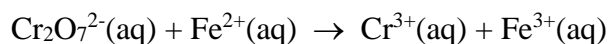
16) What mass of aluminum metal can be produced per hour in the electrolysis of molten aluminum salt (containing Al^{3+} ion) by a current of 25. A?

17) The K_{sp} of $\text{Zn}(\text{OH})_2$ is 1.8×10^{-14} . Find E°_{cell} for the half reaction

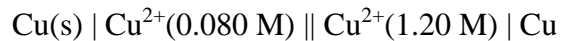


18) A metal forms from the fluoride compound MF_3 . Electrolysis of molten MF_3 by a current of 3.86 A for 16.2 minutes deposits 1.25 g of metal. What is the molar mass of the metal?

19) (18.66) The oxidation of 25.00 mL of a solution containing Fe^{2+} requires 26.00 mL of a 0.0250 M solution of $\text{K}_2\text{Cr}_2\text{O}_7$ in acidic solution. Balance the following equation, and calculate the molar concentration of Fe^{2+} . The unbalanced redox reaction is



20) (18.77) Calculate the emf of the following concentration cell at 25. °C



21) (18.87) In an electrolysis experiment a student passes the same quantity of electricity through two electrolytic cells, one containing a silver salt and the other containing a gold salt. Over a certain period of time the student finds that 2.64 g of Ag and 1.61 g of Au are deposited at the cathodes. What is the oxidation state of gold in the gold salt? (NOTE: Recall that the only common oxidation number for silver is +1)