Unit 4 Learning Objectives and Problem Assignment

Chemistry 1442
Chapters 20 and 21, and Section 4.5
***Principles of General Chemistry*, by Silberberg**

Chapter 20: Thermodynamics

1. Review the following concepts from Chapter 6:
   - First Law of Thermodynamics (pages 181-182)
   - State function (pages 183-184)
   - $\Delta H°_{rxn}$ (pages 185-186)
   - Hess's Law (pages 192-194)
   - $\Delta H°_f$ (standard enthalpy of formation, pages 194-196)
2. Know and be able to use the following relationships:
   $\Delta S_{surr} = -\Delta H / T$
   $\Delta G = \Delta H - T\Delta S$
   $\Delta G = \Delta G° + RT \ln Q$
   $\Delta G° = - RT \ln K$
   $w_{max} = - \Delta G$
3. Understand and be able to correctly apply the following concepts:
   - spontaneous processes
   - reversible and irreversible processes
   - entropy
   - Gibbs free energy
4. Know and be able to apply the three laws of thermodynamics.
5. Be able to predict the sign of ΔS for a chemical or physical change.
6. Be able to determine the standard entropy of reaction ($\Delta S°_{rxn}$) from the standard molar entropies of products and reactants ($S°$).
7. Use the equation $\Delta G = \Delta H - T\Delta S$ to calculate the free energy of reaction and to determine the temperature at which a nonspontaneous reaction becomes spontaneous.
8. Be able to determine the standard free energy of reaction ($\Delta G°_{rxn}$) using either:
   1) $\Delta G = \Delta H - T\Delta S$, or
   2) standard free energies of formation.
9. Calculate the free energy of reaction for a system having nonstandard pressures and concentrations.
10. From the standard free energy of reaction, calculate the value of the equilibrium constant, and vice versa.

Chapter 20 Problem Assignment:

2, 5, 6, 8, 10, 12, 14, 16, 25, 26, 27, 29, 31, 34, 36, 38, 39, 41, 43, 45, 47, 51, 53, 54, 56, 58, 60, 62, 64

Sec. 4.5: Oxidation-Reduction Reactions, (pages 123-126)

1. Be able to define and correctly use the following terms:
   - oxidation
   - reduction
   - redox reaction
   - half reaction
   - oxidizing agent
   - reducing agent
2. Correctly assign the oxidation state (also called oxidation number) to any element in a compound or ion.
3. In an oxidation-reduction reaction, be able to identify the substance oxidized and the substance reduced.
4. Be able to identify the oxidizing agent and the reducing agent.

Chapter 4 Problem Assignment:

45, 46, 48, 50, 52, 54, 56

Chapter 21. Electrochemistry,

1. Be able to balance redox reactions, whether they occur in acidic or basic solution.
2. Understand and be able to apply the following concepts:
   - voltaic cell (also called galvanic cell)
   - electrolytic cell/electrolysis
   - half reaction
   - anode
   - cathode
   - cell potential (E)
   - standard cell potential (E°)
3. Be able to use the table of standard reduction potentials (Table 21.2, page 696 and Appendix D, p. A-14) to determine the standard cell potential (E°) for a voltaic cell.
4. Use the table of standard reduction potentials to compare substances and determine which is the stronger oxidizing agent and which is the stronger reducing agent.
5. Understand how voltaic cells work. Be able to determine which electrode will be the anode, and which will be the cathode. Know the direction of electron flow and of ion transport in a voltaic cell.
6. Be able to write the overall balanced equation for a voltaic cell.
7. Be able to describe any voltaic cell using the shorthand line notation.
8. Know and be able to use the following relationships:
   $\Delta G = - w_{max} = -nFE$
   $\Delta G° = -nFE°$
   $E = E° – (0.0592/n) \log Q$
   $E° = (0.0592/n) \log K$
9. Use the Nernst equation ($E = E° – (0.0592/n) \log Q$) to determine the cell potential (E) of a cell under non-standard conditions.
10. Understand how concentration cells work, and be able to calculate the cell potential of a concentration cell.
11. Be able to determine the equilibrium constant, K, from the standard cell potential, E°.
12. Understand the concepts discussed in section 21.5 related to simple batteries and fuel cells.
13. Understand that the corrosion of metals is a redox reaction, and understand how corrosion can be prevented by cathodic protection. Understand the term "sacrificial anode."
14. Be able to predict the half-cell reactions when aqueous solutions of salts are electrolyzed.
15. Be able to perform calculations involving electrolysis, using the following relationships:
    charge(C) = current(A) x time(s), 1 F =96,485 C/mol e^-
16. Understand the concepts discussed in section 17.8 related to commercial electrolytic processes.

Chapter 21 Problem Assignment.

1, 2, 3, 5, 7, 10, 12, 13, 16, 18, 20, 22, 25, 27, 29, 31, 33, 35, 39, 44, 45, 47, 49, 51, 53, 57, 62, 66, 68, 70, 72, 74, 76, 78, 80, 82