Chapter 12
Thermodynamics: Why Chemical Reactions Happen
Learning Objectives

1-6-2023

To satisfy the minimum requirements for this course, you should be able to:

1. Describe the features of spontaneous and nonspontaneous processes; be able to provide an example of each.

2. State the second law of thermodynamics and explain the role that entropy plays in determining whether a process will be spontaneous.

3. Describe how entropy is related to randomness/disorder/number of possible microstates of a system, and ultimately, to the dispersal of energy. Be able to:
   - recognize that the number of available microstates and hence the entropy of a substance generally increases with the number of particles in the system, and also the size and complexity of the molecular structure
   - predict whether the sign of ΔS_{rxn} is positive, negative, or near zero for a chemical or physical change.
   - describe how and why the entropy of a substance changes with temperature or when a phase change occurs and be able to use the equation 12.3 $\left(\Delta S = \frac{q_{rev}}{T}\right)$.
   - be able to describe the role of entropy in the solution process.
   - calculate $\Delta S°_{rxn}$ for any reaction from tabulated standard molar entropy values, S° (found in Table A4.3, Appendix 4, pp. APP-18 - APP-24).

4. State the third law of thermodynamics and explain standard molar entropy, S°.

5. Calculate the standard free-energy change, $\Delta G°_{rxn}$, at 25°C using tabulated standard free energy of formation ($\Delta G°_f$) values (found in Table A4.3, Appendix 4, pp. APP-18 - APP-24) or, given appropriate data, using equation 12.11 ($\Delta G°_{rxn} = \Delta H°_{rxn} - T\,\Delta S°_{rxn}$)

6. Explain the relationship between the free-energy change, ΔG_{rxn} and the work available for a process, and relate the sign of the free-energy change, ΔG_{rxn}, to the spontaneity of a process in the forward direction.

7. Predict and calculate how ΔG_{rxn} will change with temperature, given the signs and/or values for ΔH_{rxn} and ΔS_{rxn}.

8. NavApp: Thermodynamics of the CO_2 Scrubber
   - be able to relate ΔH, ΔS, and ΔG to the MEA + CO_2 chemical equilibrium

Note - Section 12.8 (Driving the Human Engine: Coupled Reactions) is not assigned.