

Chapter 12
Thermodynamics: Why Chemical Reactions Happen
Learning Objectives

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/dispersal of energy and
 - 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 ($\Delta S = \frac{q_{\text{rev}}}{T}$).
 - be able to describe the role of entropy in the solution process.
 - calculate $\Delta S^{\circ}_{\text{rxn}}$ 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, $\Delta G^{\circ}_{\text{rxn}}$, at 25°C from tabulated standard free energies of formation $\Delta G^{\circ}_{\text{f}}$ or using equation 12.11 ($\Delta G^{\circ}_{\text{rxn}} = \Delta H^{\circ}_{\text{rxn}} - T \Delta S^{\circ}_{\text{rxn}}$) (found in Table A4.3, Appendix 4, pp. APP-18 - APP-24).
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 CO₂ Scrubber
 - be able to relate ΔH , ΔS , and ΔG to the MEA + CO₂ chemical equilibrium