

## CHAPTER 13 LEARNING OBJECTIVES

### Learning Objectives

You should be able to:

1. Understand what is meant by the terms “spontaneous” or “non-spontaneous” when these are used in a thermodynamic sense, and give familiar examples of each type of process.
2. Describe how entropy is related to randomness or disorder, and qualitatively predict whether the sign of  $\Delta S$  is positive, negative, or near zero for a chemical or physical change.
3. Explain the second law of thermodynamics.
4. Explain the third law of thermodynamics.
5. Describe how and why the entropy of a substance changes with temperature or when a phase change occurs.
6. Calculate  $\Delta S^\circ$  for any reaction from tabulated absolute entropy values,  $S^\circ$ .
7. Explain the relationship between the sign of the free-energy change,  $\Delta G$ , and whether a process is spontaneous in the forward direction.
8. Predict how  $\Delta G$  will change with temperature, given the signs for  $\Delta H$  and  $\Delta S$ .
9. Use the equation  $\Delta G = \Delta H - T\Delta S$  to calculate the free energy change for a reaction and to determine the temperature at which a nonspontaneous reaction becomes spontaneous.
10. Calculate the standard free-energy change,  $\Delta G^\circ$ , from standard free energies of formation.
11. Distinguish between thermodynamic stability and kinetic stability.
12. Use the change in enthalpy and the change in entropy to qualitatively predict whether products are favored over reactants.