

## 18.4

**ENTROPY AND FREE ENERGY****Section Review****Objectives**

- Identify two characteristics of spontaneous reactions
- Describe the role of entropy in chemical reactions
- Identify two factors that determine the spontaneity of a reaction
- Define Gibbs free-energy change

**Vocabulary**

- free energy
- spontaneous reaction
- nonspontaneous reactions
- entropy
- law of disorder
- Gibbs free-energy change

**Key Equation**

- $\Delta G = \Delta H - T\Delta S$

**Part A Completion**

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

- Reactions that actually occur as written are called   1   **1.** \_\_\_\_\_  
 reactions. Equations for other reactions may be written, but the **2.** \_\_\_\_\_  
 reactions are   2  . All spontaneous reactions release   3   **3.** \_\_\_\_\_  
 that becomes available to do   4  . This energy is called   5  . **4.** \_\_\_\_\_  
 It is the natural tendency for all things to go to lower   6   **5.** \_\_\_\_\_  
 and toward   7   disorder. In addition to the change in heat **6.** \_\_\_\_\_  
 energy,   8   is a factor that determines whether a reaction **7.** \_\_\_\_\_  
 is spontaneous. **8.** \_\_\_\_\_
- Entropy is a measure of the   9   of a system. The   10   **9.** \_\_\_\_\_  
 states that processes move in the direction of   11   disorder. **10.** \_\_\_\_\_  
**11.** \_\_\_\_\_

## Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- \_\_\_\_\_ 12. An exothermic reaction is a spontaneous reaction.
- \_\_\_\_\_ 13. The numerical value of  $\Delta G$  is negative in spontaneous processes because the system loses free energy.
- \_\_\_\_\_ 14. Some spontaneous reactions appear to be nonspontaneous because their rate of reaction is slow.
- \_\_\_\_\_ 15. Spontaneous reactions release free energy.
- \_\_\_\_\_ 16. Entropy will increase in a spontaneous reaction.

## Part C Matching

Match each description in Column B to the correct term in Column A.

### Column A

- \_\_\_\_\_ 17. free energy
- \_\_\_\_\_ 18. spontaneous reactions
- \_\_\_\_\_ 19. nonspontaneous reactions
- \_\_\_\_\_ 20. entropy
- \_\_\_\_\_ 21. law of disorder
- \_\_\_\_\_ 22. Gibbs free-energy change

### Column B

- a. measure of the disorder of a system
- b. maximum amount of energy that can be coupled to another process to do work
- c. energy in a reaction that is available to do work
- d. It is the natural tendency of systems to move in the direction of maximum disorder.
- e. reactions that do not give products under the specified conditions
- f. reactions that favor formation of products under the specified conditions

## Part D Questions

Answer the following in the space provided.

23. In each of the following pairs, choose the system with the higher entropy.
- a. a heap of loose stamps or stamps in an album \_\_\_\_\_
- b. ice cubes in their tray or ice cubes in a bucket \_\_\_\_\_
- c. 10 mL of water at 100°C or 10 mL of steam at 100°C \_\_\_\_\_
- d. the people watching the parade or a parade \_\_\_\_\_
24. Which combination of factors will always give a spontaneous reaction?
- a. heat absorbed, entropy increases
- b. heat released, entropy increases
- c. heat released, entropy decreases
- d. heat absorbed, entropy decreases
25. Which combination described in question 24 will never give a spontaneous reaction?