SECTION 4

Diffusion and Effusion

OBJECTIVES

- Describe the process of diffusion.
- State Graham's law of effusion.
- State the relationship between the average molecular velocities of two gases and their molar masses.

The constant motion of gas molecules causes them to spread out to fill any container in which they are placed. The gradual mixing of two or more gases due to their spontaneous, random motion is known as *diffusion,* illustrated in **Figure 14.** *Effusion* is the process whereby the molecules of a gas confined in a container randomly pass through a tiny opening in the container. In this section, you will learn how effusion can be used to estimate the molar mass of a gas.

Graham's Law of Effusion

The rates of effusion and diffusion depend on the relative velocities of gas molecules. The velocity of a gas varies inversely with the square root of its molar mass. Lighter molecules move faster than heavier molecules at the same temperature.

Recall that the average kinetic energy of the molecules in any gas depends only on the temperature and equals $\frac{1}{2}mv^2$. For two different gases, A and B, at the same temperature, the following relationship is true.

$$\frac{1}{2}M_A v_A{}^2 = \frac{1}{2}M_B v_B{}^2$$

extension

Chemical Content

Go to **go.hrw.com** for more information on how Graham's law can be derived from the equality of the kinetic energy of two gases.

Keyword: HC6GASX

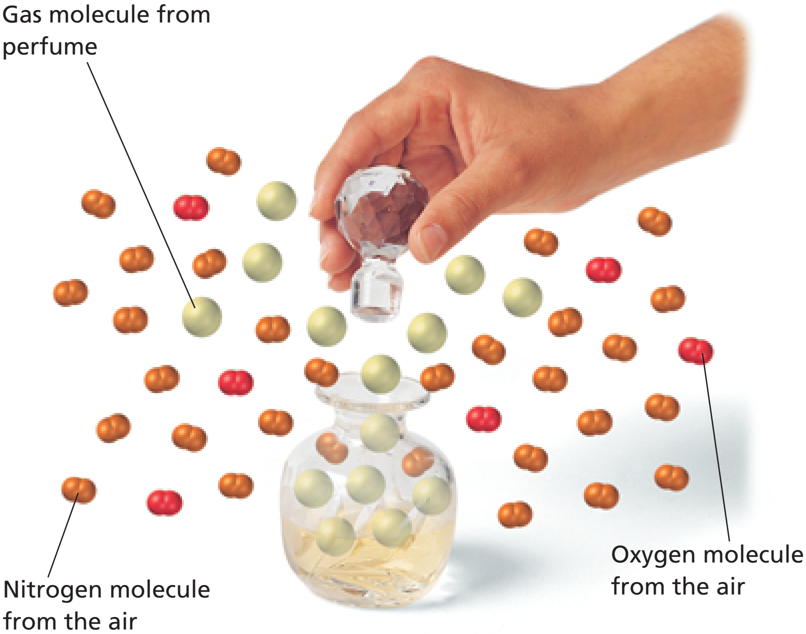

FIGURE 14 When a bottle of perfume is opened, some of its molecules diffuse into the air and mix with the molecules in the air. At the same time, molecules from the air, such as nitrogen and oxygen, diffuse into the bottle and mix with the gaseous scent molecules.