CHEMISTRY INTERACTIVE TUTOR

Module 6: Gas Laws

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The SI unit for force is the **newton,** (N). *It is the force that will increase the speed of a one-kilogram mass by one meter per second each second that the force is applied.* At Earth's surface, gravity has an acceleration of 9.8 m/s^2. Consider a ballet dancer with a mass of 51 kg, as shown in **Figure 1.** A mass of 51 kg exerts a force of 500 N (51 kg × 9.8 m/s^2) on Earth's surface. No matter how the dancer stands, she exerts that much force against the floor. But the pressure exerted against the floor depends on the area of contact. When the dancer rests her weight on the soles of both feet, as shown in **Figure 1a,** the area of contact with the floor is about 325 cm^2. The pressure, or force per unit area, when she stands in this manner is 500 N/325 cm^2, or roughly 1.5 N/cm^2. When she stands on her toes, as in **Figure 1b,** the total area of contact with the floor is only 13 cm^2. The pressure exerted is then equal to 500 N/13 cm^2—roughly 38 N/cm^2. And when she stands on one toe, as in **Figure 1c,** the pressure exerted is twice that, or about 77 N/cm^2. Thus, the same force applied to a smaller area results in a greater pressure.

The atmosphere—the shell of air surrounding Earth—exerts pressure. **Figure 2** shows that atmospheric pressure at sea level is about equal to the weight of a 1.03 kg mass per square centimeter of surface, or 10.1 N/cm^2. The pressure of the atmosphere can be thought of as caused by the weight of the gases that compose the atmosphere. The atmosphere contains about 78% nitrogen, 21% oxygen, and 1% other gases, including argon and carbon dioxide. Atmospheric pressure is the sum of the individual pressures of the various gases in the atmosphere.

Your ears "pop" when you fly in an airplane because the density—and therefore the pressure—of the air is lower at higher altitudes. The popping happens when the air pressure inside your ears changes to reach the same pressure as the air inside the cabin.

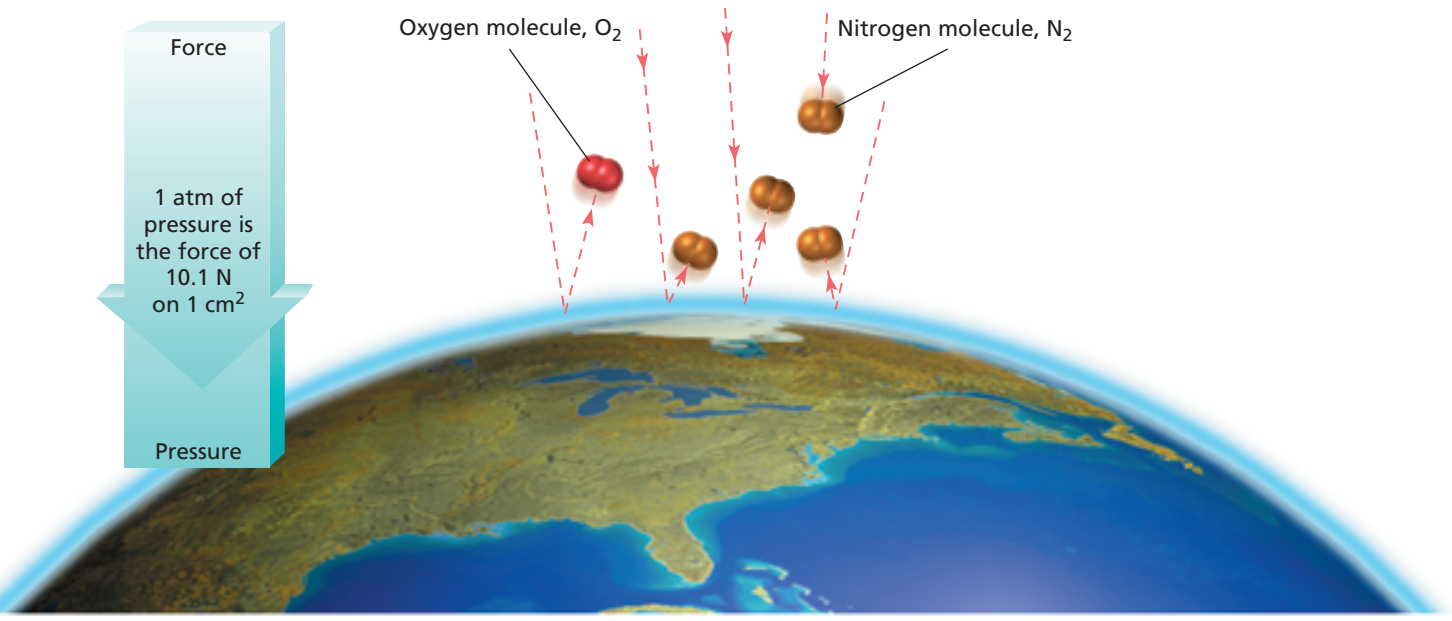

FIGURE 2 Air molecules—most of which are nitrogen or oxygen—collide with Earth's surface, creating a pressure of 10.1 N/cm^2.