Fluid Pressure

You learned about fluid pressure and Bernoulli's principle in the chapter "Fluid Mechanics." This feature discusses some additional topics related to fluid pressure, including atmospheric pressure and the kinetic theory of gases. It also covers Bernoulli's equation, which is a more general form of Bernoulli's principle.

Atmospheric pressure

The weight of the air in the upper portion of Earth's atmosphere exerts pressure on the layers of air below. This pressure is called *atmospheric pressure.* The force that atmospheric pressure exerts on our bodies is extremely large. (Assuming a body area of 2 m^2, this force is on the order of 200 000 N, or 40 000 lb.) How can we exist under such tremendous forces without our bodies collapsing? The answer is that our body cavities and tissues are permeated with fluids and gases that are pushing outward with a pressure equal to that of the atmosphere. Consequently, our bodies are in equilibrium—the force of the atmosphere pushing in equals the internal force pushing out.

An instrument that is commonly used to measure atmospheric pressure is the *mercury barometer.* **Figure 1** shows a very simple mercury barometer. A long tube that is open at one end and closed at the other is filled with mercury and then inverted into a dish of mercury. Once the tube is inverted, the mercury does not empty into the bowl. Instead, the atmosphere exerts a pressure on the mercury in the bowl. This atmospheric pressure pushes the mercury in the tube to some height above the bowl. In this way, the force exerted on the bowl of mercury by the atmosphere is equal to the weight of the column of mercury in the tube. Any change in the height of the column of mercury means that the atmosphere's pressure has changed.

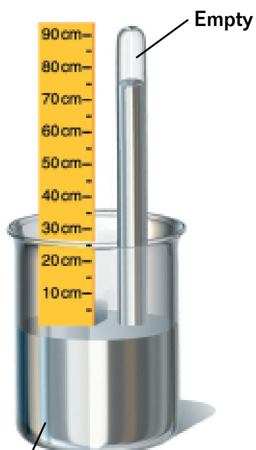

Figure 1
The height of the mercury in the tube of a barometer indicates the atmospheric pressure. (This illustration is not drawn to scale.)

Kinetic theory of gases

Many models of a gas have been developed over the years. Almost all of these models attempt to explain the macroscopic properties of a gas, such as pressure, in terms of events occurring in the gas on a microscopic scale. The most successful model by far is the *kinetic theory of gases.*

In kinetic theory, gas particles are likened to a collection of billiard balls that constantly collide with one another. This simple model is successful in explaining many of the macroscopic properties of a gas. For instance, as these particles strike a wall of a container, they transfer some of their momentum during the collision. The rate of transfer of momentum to the container wall is equal to the force exerted by the gas on the container wall, in accordance with the impulse-momentum theorem. This force per unit area is the gas pressure.