Teach, *continued*

Teaching Key Ideas

Bernoulli's Principle Ask students how a sheet of paper will move if you blow across its upper surface. (A common misconception is that it will move downward because of air pressure.) Have each student hold a sheet of paper so that it bends downward and then blow a steady stream of air above the paper. Ask how Bernoulli's principle explains their observations. (The air moving above the paper causes a decrease in pressure. The higher air pressure below the paper pushes it upward.) LS Logical/Verbal

Answer to caption question

Because the pressure is reduced, the speed of the air (a fluid) increases.

Close

Reteaching Key Ideas

Changing Forces Place a table tennis ball and a hard ball that is denser than water in a bowl of water. When putting the balls in the water, initially push each ball to the bottom and release. Ask the students to explain the difference in the actions of the balls. (For the table tennis ball, the buoyant force is greater than the gravitational force. When the force that is holding it down is removed, the table tennis ball comes to the surface rapidly. For the other ball, the buoyant force is less than the force of gravity, so the ball remains at the bottom of the bowl when the force of the hand is removed.) LS Visual/Kinesthetic

viscosity (vis KAHS uh tee) the resistance of a gas or liquid to flow

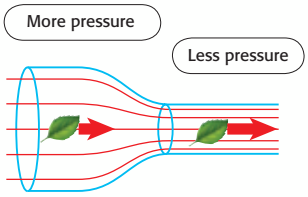


Figure 7 This leaf speeds up when it enters the narrow part of the pipe, where there is less pressure. **How does this example illustrate Bernoulli's principle?**

Viscosity depends on particle attraction.

Honey dripping from a spoon flows more slowly than lemonade poured from a pitcher. A liquid's resistance to flow is called **viscosity.** In general, the stronger the attraction between a liquid's particles is, the more viscous the liquid is. Honey flows more slowly than lemonade because honey has a higher viscosity than lemonade.

Fluid pressure decreases as speed increases.

Imagine a waterlogged leaf being carried along by water in a pipe, as **Figure 7** shows. The water will move faster through the narrow part of the pipe than through the wider part. Therefore, as the water carries the leaf into the narrow part of the pipe, the leaf moves faster.

If you measure the pressure at different points, you would find that the water pressure in front of the leaf is less than the pressure behind the leaf. The pressure difference causes the leaf and the water around it to accelerate as the leaf enters the narrow part of the tube. This behavior illustrates a general principle, known as *Bernoulli's principle,* which states that as the speed of a moving fluid increases, the pressure of the moving fluid decreases. This property of moving fluids was first described in the 18th century by Daniel Bernoulli, a Swiss mathematician.

Section 3 Review

KEY IDEAS

1. **Explain** how differences in fluid pressure create buoyant force on an object.
2. **State** Archimedes' principle, and give an example of how you could determine a buoyant force.
3. **State** Pascal's principle. Give an example of its use.
4. **Compare** the viscosity of milk and the viscosity of molasses.

CRITICAL THINKING

5. **Applying Concepts** An object weighs 20 N. It displaces a volume of water that weighs 15 N.
   a. What is the buoyant force on the object?
   b. Will the object float or sink? Explain.
6. **Drawing Conclusions** Iron has a density of 7.9 g/cm^3. Mercury has a density of 13.6 g/cm^3. Will iron float or sink in mercury? Explain.
7. **Making Inferences** Two boats in a flowing river are sailing side-by-side with only a narrow space between them.
   a. What happens to the fluid speed and the pressure between the two boats?
   b. How could the changes in fluid speed and pressure lead to a collision of the boats?

Math Skills

8. A water bed that has an area of 3.75 m^2 weighs 1,025 N. Find the pressure that the water bed exerts on the floor.
9. The small piston of a hydraulic lift has an area of 0.020 m^2. A car weighing 12,000 N is mounted on the large piston (area = 0.90 m^2). What force must be applied to the small piston to support the car?

Formative Assessment

Why does a rubber duck float in your bathtub?

A. The rubber duck exerts an upward force on the water. (Incorrect. The rubber duck exerts a downward, not upward, force on the water.)

B. The rubber duck is denser than the water is. (Incorrect. If the duck were denser than the water, it would sink.)

C. The rubber duck is less dense than the water is. (Correct. The rubber duck is less dense than water is, and the weight of the water displaced is equal to the weight of the duck. As a result, the duck is buoyed up.)

D. The water exerts a downward force on the duck. (Incorrect. The water exerts an upward, not downward, force on the duck.)

Answers to Section Review

1. Sample answer: Fluid pressure is exerted on all sides of an object. The horizontal pressures cancel each other out. The pressure exerted at the bottom is greater than the pressure exerted at the top because pressure increases with depth. This creates an overall upward, or buoyant, force.
2. Archimedes' principle states that the buoyant force on an object in a fluid equals the weight of the fluid that the object displaces. To find buoyant force, weigh the fluid displaced by an object.
3. Pascal's principle states that pressure applied to a fluid in a closed container is transmitted equally throughout the fluid. The principle is used in hydraulic lifts.

Answers continued on p. 109A