Water

Overview

Water is a part of your everyday life. You drink it, bathe in it, cook with it, and even may enjoy an occasional walk in the rain. Because of its presence everywhere, water seems most usual. Water, however, is very unusual and has unique properties that are the very basis of our living world.

About 70% of the Earth's surface is covered by water, but did you ever wonder where it all came from? Most scientists believe that the Earth's existing water supply was formed billions of years ago when oxygen and hydrogen gases combined to form the water vapor that spewed forth from primitive volcanoes. The water vapor fell to the Earth's surface as rain. Over the millennia, continuous evaporation and precipitation have kept the water cycling (the hydrological cycle) and the amount of water on our planet has remained constant.

Is It Possible to Walk on Water?

Have you ever seen a water strider or other small insect "walk on water" in a swimming pool? When you wash your car, does the water form beads on the surface? The high surface tension of water is responsible for this behavior.

Surface tension is caused by the differences in attractions among water molecules on the surface of a liquid as compared to those at a greater depth in the solution (Figure 3A-1). Water molecules in the middle of a solution are surrounded by other water molecules that attract one another uniformly in all directions. On the surface, however, water molecules form hydrogen bonds only sideways and inward—not with molecules in the air above. The concentration of hydrogen bonds pulling together across the surface and toward the liquid below form a kind of film or "skin" at the surface.

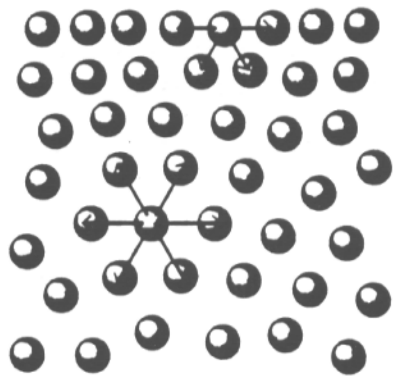

Figure 3A-1 *The attractive forces of water molecules at the surface are concentrated across the surface and inward. Molecules below the surface are attracted in all directions.*

Figure 3A-2 *Notice how the waterbug "stretches" the surface of the water.*

"Stretching" the surface of water requires force (energy) to pull the surface molecules apart. For example, a waterbug on the surface of a pond exerts force that "stretches" the surface, increasing its area (Figure 3A-2).

When no force is exerted on the surface, water molecules naturally maintain a minimum surface area. (An elastic band, when not being stretched by force, maintains its minimum length.) A sphere is the three-dimensional shape with the smallest amount of surface area, which is why water dripping from a faucet forms spherical drops.

Objective

☐ Demonstrate the surface tension property of water.

Procedure

To demonstrate just how strong the surface tension of water can be, we will observe how far above the rim of a glass we can make water climb.

1. Fill a drinking glass exactly to its rim with water. Gently and slowly slip pennies, one at a time and sideways, down the side of the glass.

   a. Does the water rise above the rim of the glass? ______ *b. What shape does the water exhibit above the rim of the glass?* ______ *c. Why does this happen?* ______

   d. How many pennies can you add before a single drop of water is forced over the side? ______
   e. Why do you think water is finally forced over the side of the glass? ______

2. Refill the glass with water and try to float a dry needle on the surface.

   f. Why must the needle be dry? ______

3. Obtain a clean glass slide and use a pipette or dropper to place a drop of water on its surface.

   g. What happens? ______

4. Obtain a clean glass slide and use your finger to cover the surface with a thin film of cooking oil. Cooking oil is composed of lipids that are nonpolar and thus hydrophobic ("water-hating"). Place a drop of water on the surface of the slide.

   h. What happens? ______ *i. Why?* ______

5. Now, obtain a clean glass slide and use your finger to cover the surface with a thin film of detergent. Detergent is composed of fatty acids in association with positively charged ions (cations) such as Na^+ or K^+. These associations, called "soaps of fatty acids," are polar and hydrophilic ("water-loving"). Their charged ends can interact with polar water molecules (see Figure 3C-2, page 3-9.) Place a drop of water on the surface of the slide.

   j. What happens? ______ *k. Why?* ______

When the windshield of your car is clean, water spreads evenly over the glass. But, after a while, the grease and oil from the road surface collect on the windshield and water "beads up," spreading less evenly. **Wetting** is the property of liquids that allows them to spread across surfaces due to attractive forces or adherence between the liquid and the surface material.

l. Did the previous experiment demonstrate this wetting effect? Explain. ______

m. Did attractive forces exist between water and the slide covered with cooking oil? ______ *n. Why or why not?* ______

o. Did attractive forces exist between water molecules and the slide covered with detergent? ______ *p. Why or why not?* ______