Water Is Cohesive and Adhesive

Have you ever filled up a glass of water to the very top and then slowly added a few more drops? Before it overflows, the water forms a dome-like shape above the rim of the glass. Water can stay above the glass because of the property of **cohesion**. In cohesion, water molecules are attracted to each other because of hydrogen bonding, keeping the molecules together at the liquid-air, gas, interface. Cohesion gives rise to **surface tension**, the capacity of a substance to withstand rupture when placed under tension or stress. When you drop a small scrap of paper onto a droplet of water, the paper floats on top of the water droplet. The paper floats even though the object is denser, heavier than the water. This occurs because of the surface tension that is created by the water molecules. Cohesion and surface tension keep the water molecules intact and the item floating on the top of the water's surface. It is even possible to "float" a steel needle on top of a glass of water if you place it gently without breaking the surface tension (Figure 2.28).

Figure 2.28 The weight of a needle on top of water pulls the surface tension downward; at the same time, the surface tension of the water is pulling it up, suspending the needle on the water, and keeping it from sinking. (credit: Cory Zanker/ Biology 2E OpenStax)

Water is also said to be **adhesive**, meaning that there is an attraction between water molecules and other types of molecules. This is observed when water "climbs" up a straw placed in a glass of water (Figure 2.29). You will notice that the water appears to be higher on the sides of the straw than in the middle. This is because the water molecules are attracted to the straw and therefore adhere to it.

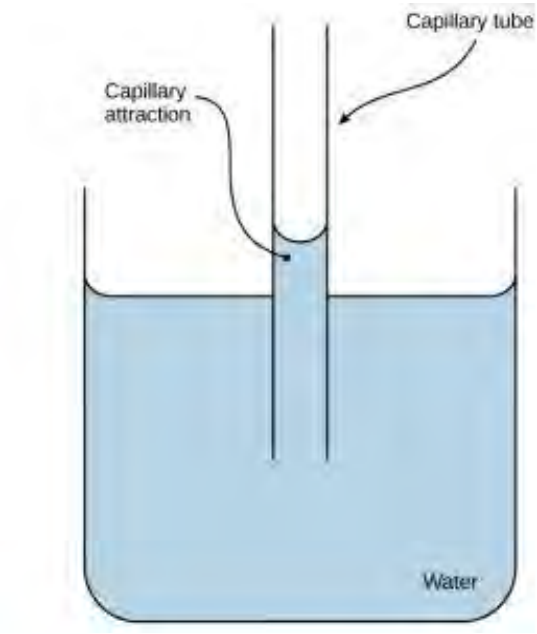

Figure 2.29 shows a straw submerged in water, demonstrating adhesion. (credit: modification of work by Pearson-Scott Foresman, donated to the Wikimedia Foundation/ Biology 2E OpenStax)

Cohesive and adhesive forces are important for sustaining life. For example, because of these forces, water can flow up from the roots of plants to the leaves where photosynthesis occurs. If plants cannot access water via their roots, they cannot make their food and, therefore, cannot survive. In another example, insects such as the water strider (Figure 2.30) use the water's surface tension to stay afloat on the water's surface where they will mate. Without water's unique properties, these individuals would not survive.

Figure 2.30 Water's cohesive and adhesive properties allow this water strider (Gerris sp.) to stay afloat. (credit: Tim Vickers/ Biology 2E OpenStax)

CONCEPTS IN ACTION- To learn more about water, visit the U.S. Geological Survey Water Science for Schools: All About Water! Website

Section Summary

Water has many properties that are critical to maintaining life. Water is polar, allowing for the formation of hydrogen bonds, which allow ions and other polar molecules to dissolve in water. Therefore, water is an excellent solvent. The hydrogen bonds between water molecules give water the ability to hold heat better than many other substances. As the temperature rises, the hydrogen bonds between water continually break and reform. This allows for the overall temperature to remain stable, although increased energy is added to the system. Water's cohesive forces allow for the property of surface tension. All of these unique properties of water are important for the survival of living organisms.

Exercises

1. Which of the following statements is not true?
    a. Water is polar.
    b. Water stabilizes temperature.
    c. Water is essential for life.
    d. Water is the most abundant atom in Earth's atmosphere.

2. Water can absorb a large amount of heat energy before the temperature rises due to large amounts of:
    a. polar covalent bonds
    b. hydrogen bonds
    c. its cohesive properties
    d. its adhesive properties

3. Which of the following would be hydrophobic?
    a. NaCl (table salt)
    b. Sugar
    c. Oil
    d. Water

4. Why can some insects walk on water?

5. Explain why water is an excellent solvent.

Answers

1. (d)
2. (b)
3. (c)
4. Some insects can walk on water, although they are heavier (denser) than water, because of the surface tension of water. Surface tension results from cohesion, or the attraction between water molecules at the surface of the body of water [the liquid-air (gas) interface].
5. Water molecules are polar, meaning they have separated partial positive and negative charges. Because of these charges, water molecules can surround charged particles created when a substance dissociates. The surrounding layer of water molecules stabilizes the ion and keeps differently charged ions from reassociating, so the substance stays dissolved.