2.2E: Water’s Cohesive and Adhesive Properties

Cohesion allows substances to withstand rupture when placed under stress while adhesion is the attraction between water and other molecules.

Learning Objectives

• Describe the cohesive and adhesive properties of water.

Key Points

• Cohesion holds hydrogen bonds together to create surface tension on water.
• Since water is attracted to other molecules, adhesive forces pull the water toward other molecules.
• Water is transported in plants through both cohesive and adhesive forces; these forces pull water and the dissolved minerals from the roots to the leaves and other parts of the plant.

Key Terms

• adhesion: The ability of a substance to stick to an unlike substance; attraction between unlike molecules
• cohesion: Various intermolecular forces that hold solids and liquids together; attraction between like molecules
Water's Cohesive and Adhesive Properties

Have you ever filled 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. This 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-gas (water-air) interface, although there is no more room in the glass.

Cohesion allows for the development of surface tension, the capacity of a substance to withstand being ruptured when placed under tension or stress. This is also why water forms droplets when placed on a dry surface rather than being flattened out by gravity. When a small scrap of paper is placed onto the droplet of water, the paper floats on top of the water droplet even though paper is denser (the mass per unit volume) than the water. Cohesion and surface tension keep the hydrogen bonds of water molecules intact and support the item floating on the top. It’s even possible to “float” a needle on top of a glass of water if it is placed gently without breaking the surface tension.

Figure \(\PageIndex{1}\): Surface Tension: The weight of the needle is pulling the surface downward; at the same time, the surface tension is pulling it up, suspending it on the surface of the water and keeping it from sinking. Notice the indentation in the water around the needle.

These cohesive forces are related to water’s property of adhesion, or the attraction between water molecules and other molecules. This attraction is sometimes stronger than water’s cohesive forces, especially when the water is exposed to charged surfaces such as those found on the inside of thin glass tubes known as capillary tubes. Adhesion is observed when water “climbs” up the tube placed in a glass of water: notice that the water appears to be higher on the sides of the tube than in the middle. This is because the water molecules are attracted to the charged glass walls of the capillary more than they are to each other and therefore adhere to it. This type of adhesion is called capillary action.
Figure 1: **Adhesion**: Capillary action in a glass tube is caused by the adhesive forces exerted by the internal surface of the glass exceeding the cohesive forces between the water molecules themselves.

Why are cohesive and adhesive forces important for life? Cohesive and adhesive forces are important for the transport of water from the roots to the leaves in plants. These forces create a “pull” on the water column. This pull results from the tendency of water molecules being evaporated on the surface of the plant to stay connected to water molecules below them, and so they are pulled along. Plants use this natural phenomenon to help transport water from their roots to their leaves. Without these properties of water, plants would be unable to receive the water and the dissolved minerals they require. In another example, insects such as the water strider use the surface tension of water to stay afloat on the surface layer of water and even mate there.

Figure 1: **Cohesion & Adhesion**: Water’s cohesive and adhesive properties allow this water strider (Gerris sp.) to stay afloat.