Pearson

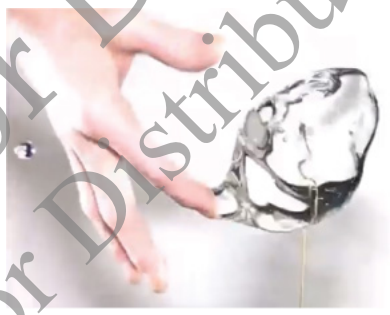
11.1: Water, No Gravity

In the space station, water won't spill. When an astronaut squeezes a full water bottle, the water squirts out like it does on Earth, but instead of falling to the floor and forming a puddle, the water moelcules stick together to form a floating, oscillating blob. Over time, the blob stops oscillating and forms a nearly perfect sphere. Why?

The reason is the main topic of this chapter: *intermolecular forces*, the attractive forces that exist among the particles that compose matter. The water molecules that compose water are attracted to one another, much like a collection of small magnets are attracted to each other. These attractions hold the water molecules together as a liquid (instead of a gas) at room temperature.

These forces also cause samples of water to clump together into a blob, which is clearly seen in the absence of gravity. Over time irregularities in the shape of the blob smooth out, and the blob becomes a sphere. The sphere is the geometrical shape with the lowest surface area to volume ratio. By forming a sphere, the water molecules maximize their interaction with one another because the sphere results in the minimum number of molecules being at the surface of the liquid, where fewer interactions occur (compared to the interior of the liquid).

Intermolecular forces exist, not only among water molecules, but among all particles that compose matter. You can see the effect of these attractive forces in this image, which shows an astronaut touching a floating blob of water in the absence of gravity.



Notice how the water sticks to the astronaut's finger. The water molecules experience an attractive force to the molecules that compose skin. This attractive force deforms the entire blob of water. *Intermolecular forces exist among all the particles that compose matter*.

Intermolecular forces are responsible for the very existence of condensed states. The state of a sample of matter —solid, liquid, or gas—depends on the magnitude of intermolecular forces among the constituent particles relative to the amount of thermal energy in the sample. The molecules and atoms composing matter are in constant random motion that increases with increasing temperature. The energy associated with this motion is *thermal energy*. When thermal energy is high relative to intermolecular forces, matter tends to be gaseous. When thermal energy is low relative to intermolecular forces, matter tends to be liquid or solid.