Density Bottle

Recommended for Chapter(s): 16

Demo #047

Procedure

1. Ask the students how many layers they see in the bottle. There are 5 possible layers from bottom to top: liquid, 1 color of beads, 2nd color of beaks, another liquid, and a gas.
2. Shake the bottle and then ask student how many layers. There are 4 possible layers from bottom to top: 1 color of beads, liquid, 2nd color of beads, and gas.
3. As the bottle sits the bottle will go back to original position. Ask student if they can explain how this happens

Clean Up

1. Return the materials to the cart in the demonstration library room.

Stockroom Notes

1. Return items to demonstration tub.
2. Return tub to the demonstration library.

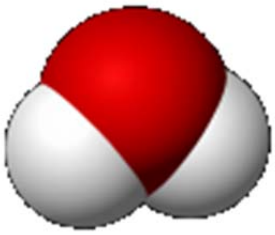
Discussion

This demonstration is an excellent way to see if student understand intermolecular forces. The bottle contains the following substances: H_2O, C_3H_7OH (isopropyl alcohol), NaCl, and 2 types of beads. Let's first focus on the water and the isopropyl alcohol. The density of water is 1.0 $\frac{g}{mL}$ and the density of isopropyl alcohol is 0.79 $\frac{g}{mL}$, therefore, before the bottle is shaken the layer on the bottom is water followed by the two layers of beads and the isopropyl alcohol is on the top.

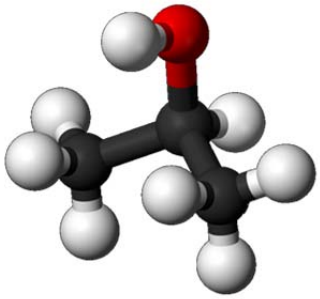
Once the bottle is shaken the water and the isopropyl mix, forming one layer that has a density in-between the two liquids. This new liquid also has a density that is in-between the two bead densities causing one of the types of beads to go to the bottom and the other to the top. The water and the isopropyl alcohol mix because they are both polar and like mixes with like. Therefore, why do the two layers separate back out? To understand this we must determine the role that NaCl is playing in the system

Salt is on ionic compound and breaks apart into its ions when dissolved in water or isopropyl alcohol. Ions (ex: Na^+ and Cl^-) are most stable in solution when they are surrounded by particles with the opposite charges. Since both H_2O and C_2H_7OH are polar they have partial positive and negative sides and can stabilize the sodium and chloride ions. However from the structures of the two solvents (see below) it can be seen

that water has the ability to form 2 hydrogen bonds while isopropyl alcohol can only form 1. Therefore, the partial negative and positive charges in water are larger in water than in isopropyl alcohol.



Water (H_2O)



Isopropyl Alcohol (C_3H_7OH)

Therefore, the sodium and chloride ions will migrate until they have only water molecules around them which essentially separates the water from the isopropyl alcohol. Once the water (and salt) separates out, it is now denser than the beads, leaving the beads in the middle. The isopropyl alcohol is less dense than the beads, therefore, is located at the top of the bottle.

Materials for demo 047

1. Density bottle