## Station 3

## LAYERED LIQUIDS

Have you ever heard the phrase "oil and water don’t mix"? First we will test that expression, then look at interesting combinations of several other liquids.

### Oil and Water

You will need the following materials:

- ¼ cup (60 ml) water
- ¼ cup (60 ml) vegetable oil
- a small glass
- food coloring

First pour the water into the glass. Add a couple of drops of food coloring and mix. Next add the oil. What do you see? Which layer is on top?

Tightly cover the glass with plastic wrap or your hand (if it's big enough). While holding the glass over a sink (in case you spill), shake the glass so that the two liquids are thoroughly mixed. Set the glass down and watch what happens. Do oil and water mix?

The word “miscibility” describes how well two substances mix. Oil and water are said to be “immiscible,” because they do not mix. The oil layer is on top of the water because of the difference in density of the two liquids. The density of a substance is the ratio of its mass (weight) to its volume. The oil is less dense than the water and so is on top.

The next experiment examines the miscibility and density of several liquids.

**Layered Liquids**

You will need the following materials:

- ¼ cup (60 ml) dark corn syrup or honey
- ¼ cup (60 ml) dishwashing liquid
- ¼ cup (60 ml) water
- ¼ cup (60 ml) vegetable oil
- ¼ cup (60 ml) rubbing alcohol
- a tall 12 ounce (350 ml) glass or clear plastic cup
- two other cups for mixing
- food coloring

Take the 12 ounce glass. Being careful not get syrup on the side of the glass; pour the syrup into the middle of the glass. Pour enough syrup in to fill the glass 1/6 of the way.

After you have added the syrup or honey, tip the glass slightly and pour an equal amount of the dishwashing liquid slowly down the side of the glass. Does the dishwashing liquid float on top of the syrup or sink to the bottom?

Next mix a few drops of food coloring with water in one of the mixing cups. Color the rubbing alcohol a different color in another mixing cup.

Be careful to add the next liquids VERY SLOWLY. They are less viscous (i.e., not as thick) and mix more easily than the previous liquids. We don't want them to mix. Tip the glass slightly, and pouring slowly down the side of the glass, add first the colored water, then the vegetable oil, and finally the colored rubbing alcohol.

On a piece of paper, make a sketch of the glass and its liquids, labeling the position of each liquid in your glass.

Why do the liquids stay separated? Can you think of several ways that the liquids in the glass are different? Try to describe some properties that differ in each of the liquids in the glass.

One property that is different in all of the liquids is color. Another property unique to each liquid is thickness (viscosity).

The property of the liquids that is responsible for the layering effect is density. Can you guess what the relationship is between the density of a liquid and its position in the glass?

Another property that keeps the liquids separate is that some of them are immiscible liquids, in other words they do not mix with each other. As you proved in the first experiment, oil and water are immiscible liquids. On the other hand, water and rubbing alcohol are miscible and will mix with each other. Water and the dishwashing liquid will also mix.

Stir up the liquids in the glass and watch what happens to the layers. Have any of the layers mixed (are they miscible in each other)? Wait a few minutes and look again. Have any of the other liquids separated?

**Alternate procedure: Rainbow in a glass.**

You will need the following materials:

• four different colors of food coloring (e.g. red, yellow, green, blue)
• five tall glasses or clear plastic cups
• ¾ cup (180 g) of granulated sugar
• a tablespoon for measuring
• 1 cup (240 ml) water

In the first glass, add one tablespoon (15 g) of sugar. In the second glass, add two tablespoons of sugar, three in the third glass, and four in the last glass. Then add three tablespoons (45 ml) of water to each glass, and stir until the sugar is dissolved. If the sugar in any of the glasses will not dissolve, add one more tablespoon (15 ml) of water to all of the glasses, and stir again. When the sugar is completely dissolved, add two or three drops of red food coloring to the first glass, yellow to the second, green to the third, and blue to the last glass.

In the remaining glass we will create our rainbow. Fill the glass about a fourth of the way with the blue sugar solution. Next, carefully add the green solution to the glass. Do this by putting a spoon in the glass, just above the level of the blue solution. Slowly pour the green solution into the spoon, raising the spoon to keep it just above the level of the liquid, until the glass is half full. Add the yellow solution, and then the red one in the same manner. What do you notice about the colored solutions?

The amount of sugar dissolved in a liquid affects its density. The blue solution has the most sugar dissolved in it and is therefore the densest. The other solutions are less dense than the blue solution, so they float on top of it. The densities of the solutions should be very close however, and the solutions are miscible, so you will see that the layers do not form well defined boundaries as in the first experiment. If done carefully enough, the colors should stay relatively separate from each other. What do you think will happen if you stir up the liquids in the glass?