Have you ever heard the expression, “Oil and water never mix?” This simple and visually stunning experiment will demonstrate the scientific principles behind this phrase – from how water and oil interact to how acids and bases work.

Objectives

- Explore the relationship between oil and water in terms of density and as hydrophilic/hydrophobic compounds.
- Observe a chemical reaction between an acid and a base.

Materials

- 1 clean, plastic soda bottle with cap* or one glass container
- Vegetable oil or baby oil
- 1 Alka-Seltzer tablet for a 16 oz soda bottle or 2 tablets for per liter bottle
- Food coloring
- Water

** It is a great idea to reuse a plastic soda bottle from a recycling bin (just wash it out before beginning the experiment).*

Introduction

Oil and water do not mix because they cannot form chemical bonds with each other. Water is made up of highly charged, hydrophilic compounds (or "water loving") while oil is made up of long chains of carbon that are hydrophobic ("scared of water"). The long chains of carbon that make up oils are not attracted to the water molecules. This causes the separation we see in this experiment as well as in our kitchen sinks and oceanic oil spills. Density describes how many molecules can fit in the same space – a dense liquid has lots of molecules packed in tightly, whereas a less dense liquid has more space between molecules. Oil will float on top of the water because it is less dense than water. Food coloring has the same density as water, so it will sink through oil and eventually mix with the water.

Alka-Seltzer is technically *both* acidic and basic. Acids are compounds that have a low pH (when put in water, they want to give off hydrogen ions). Bases are compounds that have a high pH (when they are in water, they want to release hydroxide ions). Alka-Seltzer tablets contain sodium bicarbonate (a base) and citric acid (an acid) which, when mixed with water, react with each other and produce bubbling carbon dioxide – a gas. This creates the bubbles you see within the colored fluid in the soda bottle. Gas is lighter than both oil and water and will float to the top. The bubbles bring some colored water with them as they travel up. When the gas comes out of the colored water blob, the water gets heavy again and sinks. It does this over and over again until the tablet is completely dissolved. ***Congratulations – you have just made a lava lamp!***

Research Questions

1. What happens when you add water to the plastic bottle? Why do you think this occurs?
2. What happens when you add the food coloring to the bottle? Why do you think this occurs?
3. What happens when you add the Alka-Seltzer to the bottle? Why do you think this occurs?
4. What experiments did you perform on the closed soda bottle (twisting, shaking, etc.)? What did you notice during each trial?
5. What happens if you add soap to the water/oil mixture?

Terms, Concepts and Questions to Start Background Research

- **Oil and water mixture** – Oil, a hydrophobic compound, and water, a hydrophilic compound, do not mix. See detailed discussion in Introduction section.
- **Acid-base reaction** – A chemical reaction between two substances where one is an acid and one is a base.
- **Hydrophobic compound** – A "scared of water"compound that do not dissolve easily in water.
- **Hydrophilic compound** – A "water loving"compound that easily bonds with water.

Experimental Procedure

1. Gather materials over a surface that cannot be damaged by oil or can be wiped clean. Another good option is to cover a table with old newspapers.
2. Fill the plastic bottle ¾ full with vegetable oil.
3. Add water to the neck of the bottle, leaving a little space between the water line and the top of the container. (You can always add more water at a later time.)
4. Decide on a color for your 'lava lamp' bottle. Select the food coloring accordingly.
5. Add 10 or more drops of food coloring to the bottle until a rich color is seen.
6. Break the Alka-Seltzer tablet into smaller pieces (6 to 8). Add one piece at a time observing each reaction.
7. When the bubbling stops replace the bottle cap.
8. Tip the bottle back and forth and observe the reaction. Tip, twist, and shake the bottle in different directions. Observe the reactions and take notes.

Bibliography

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