Salting Out—Density Bottle

Chemical Demonstration

Introduction

Two layers of beads are suspended in the middle of a bottle. Give the bottle a shake and the beads move to opposite ends. Then, the beads slowly move back to the starting position.

Concepts

- Density
- Non-polar vs. polar
- Solutions
- Immiscibility

Materials

Isopropyl alcohol, reagent, 400 mL
Sodium chloride, 90 g
Water, distilled or deionized
Balance, 0.1-g precision
Beads, UV-sensitive, 50 g
Bottle with cap, plastic, 1-L
Graduated cylinders, 500-mL, 2
Funnel
Pony beads, 50 g

Safety Precautions

Isopropyl alcohol is a flammable liquid and a fire hazard. It is slightly toxic by ingestion and inhalation. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Safety Data Sheets for additional safety, handling and disposal information.

Preparation

1. Add 90 grams of sodium chloride to the bottle.
2. Add 400-mL of distilled or deionized water to the bottle.
3. Cap the bottle and shake until the sodium chloride is mostly dissolved.
4. Add approximately 50 grams each of the green pony beads and UV-sensitive beads to the bottle.
5. Add 400-mL of isopropyl alcohol to the bottle.
6. Cap the bottle tightly and shake to thoroughly mix the solution. *Caution:* Pressure may build up while shaking. Slightly loosen the cap to relieve the pressure then tighten the cap again.

Procedure

1. Present the bottle to the students and allow them to write down initial observations.
2. Shake the bottle vigorously to completely mix the two liquids.
3. Set the bottle down and allow students to make observations.
4. Repeat steps 2 and 3 several times.

Disposal

The bottle may be reused for many years.

© 2016 Flinn Scientific, Inc. All Rights Reserved.

Publication No. 11345
061616

Tips

- Pony beads can be purchased from a local craft store. Beads of uniform color are recommended.
- The pony beads should be more dense than the UV-beads. Test the density bottle before performing the demonstration to ensure it works correctly.
- One package of UV-beads, Flinn Scientific Catalog No. FB1147, contains approximately 60 g of beads.
- The cap may be glued onto the bottle to prevent opening, spillage or tampering.
- The amounts may be scaled down so students can explore this phenomenon on a small scale using vegetable (food) dyes instead of beads. Food coloring dyes are large, organic molecules with charged, polar end groups. The charged ends allow the dye molecules to dissolve in water as well as organic solvents.

Discussion

Water and isopropyl alcohol are miscible liquids that form strong hydrogen bonds. When sodium chloride is added to the solution, the ionic solid dissociates. The ions attract the water molecules and disrupt the hydrogen bonds between the water and isopropyl alcohol molecules. As two liquid layers separate, the isopropyl alcohol/water solution will appear on top of the more dense aqueous sodium chloride solution. The phenomenon is known as *salting out* and is widely used to separate and purify organic compounds from aqueous mixtures. It is also used to precipitate proteins from aqueous cell extracts.

The pony beads hide the interface of the isopropyl alcohol and sodium chloride solution layers. The different colored beads have slightly different densities. Before the bottle is shaken, the translucent (UV-sensitive) beads are on top of the green beads. In this configuration, the relative densities of the beads can be reasoned. The translucent beads have a density greater than that of isopropyl alcohol, less than that of the aqueous sodium chloride solution, and less than the density of the green beads. The green beads have a density greater than those of the isopropyl alcohol and translucent beads, but less than that of the sodium chloride solution.

When the bottle is shaken, a nearly homogenous mixture of isopropyl alcohol and sodium chloride solution is formed. The density of the resulting solution changes. The change is apparent because the beads move to opposite ends of the bottle. The translucent beads move to the top and are, therefore, less dense than the solution. The green beads sink to the bottom of the bottle and are more dense than the solution. Upon standing, the beads migrate to their starting positions. This is due to the immiscibility of isopropyl alcohol and sodium chloride solutions.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
- MS-PS1Matter and Its Interactions
  - PS1.A: Structure and Properties of Matter
- MS-PS2 Motion and Stability: Forces and Interactions
  - PS2.B: Types of Interactions

Disciplinary Core Ideas: High School
- HS-PS1Matter and Its INteractions
  - PS1.A: Structure and Properties of Matter
- HS-PS2 Motion and Stability: Forces and Interactions
  - PS2.B: Types of Interactions

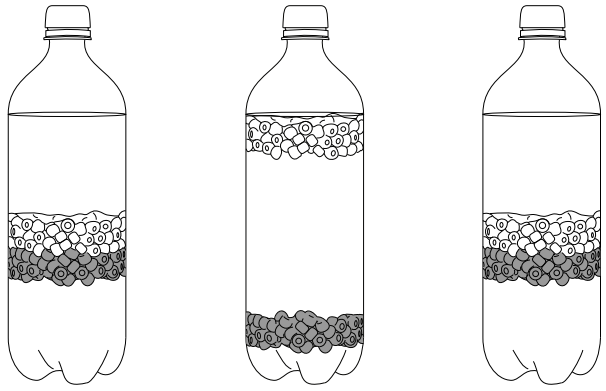
Science and Engineering Practices
- Developing and using models
- Constructing explanations and designing solutions

Crosscutting Concepts
- Systems and system models
- Structure and function

© 2016 Flinn Scientific, Inc. All Rights Reserved.

Sample Questions and Answers

1. Draw a diagram of the bottle before shaking, immediately after, and when contents come to rest.



Before *Immediately After* *At Rest*

2. Isopropyl alcohol and saturated sodium chloride solution have different densities. One has a density of 0.785 g/mL and the other 1.2 g/mL.

   a. How can you infer from your diagram which is more dense?

   The more dense material will be on the bottom of the bottles. Materials with greater density sink to the bottom.

   b. What can you infer about the relative densities of the different colored beads?

   The colorless beads are less dense than the green beads because they are floating on top of the green beads. There is no mixing between the different colored beads indicating that the beads have different densities.

3. Predict what will happen if the bottle is shaken and set back down.

   When the bottle is shaken, the beads will be all mixed up. After being set down, the beads will then quickly sort back into the colorless layer and green layer.

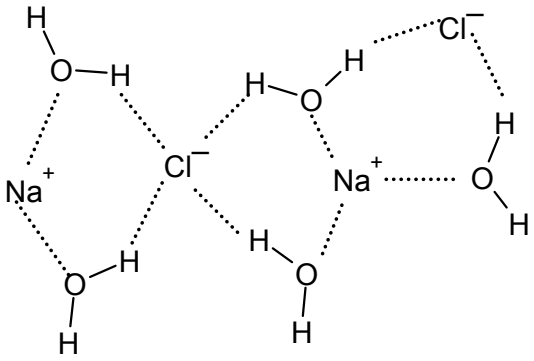
4. Write a possible explanation for what happened when the bottle was shaken and set back down.

   When the bottle was shaken, the isopropyl alcohol and sodium chloride solution mixed completely, making a homogenous solution of uniform density. The density of the solution was greater than the density of the colorless beads, so those beads floated on top. The density of the solution was less than the density of the green beads, so the green beads sank. As the bottle sat undisturbed, the isopropyl alcohol and sodium chloride solution separated, with the isopropyl alcohol on top, then the colorless beads and green beads, and the sodium chloride solution on the bottom.

© 2016 Flinn Scientific, Inc. All Rights Reserved.

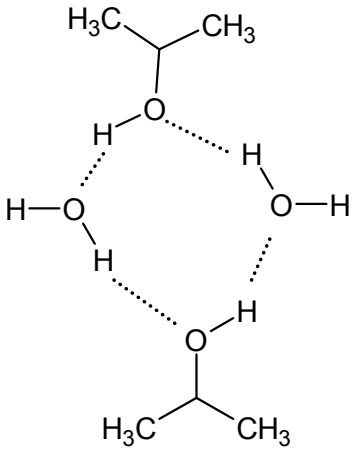
5. Draw separate molecular diagrams of how sodium chloride and isopropyl alcohol would interact in water. Identify the types of intermolecular attractions within each diagram.

Sodium chloride in water



Ion–dipole interactions

Isopropyl alcohol in water



Hydrogen bonding interactions

Acknowledgment

Special thanks and acknowledgement to Lynn Higgins, ACS Polymer Ambassador, Missouri in recognition of her creative activity idea that this demonstration is based on.

The *Salting Out—Density Bottle Demonstration Kit* is available from Flinn Scientific, Inc.

Catalog No.	Description
AP7931	Salting Out—Density Bottle Demonstration kit
OB2138	Flinn Scientific Electronic Balance, 300 x 0.1-g
FB1147	Ultraviolet Detecting Beads, Assorted, 240/pkg
I0019	Isopropyl Alcohol, Reagent, 500 mL
S0061	Sodium Chloride, Reagent, 500 g

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

© 2016 Flinn Scientific, Inc. All Rights Reserved.