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Catalog No. AP9831
Publication No. 9831

Colorful Salting Out

Chemical Demonstration Kit

Introduction

Two immiscible colorless liquids are in a bottle. A green marker is added to the bottle and the contents shaken, dying the solutions inside. With the marker again removed the solutions are now observed to be yellow and blue. Give the bottle a shake and the solution turns back to green. The layers then slowly return to yellow and blue.

Concepts

- Chromatography
- Solutions
- Non-polar vs. polar
- Immiscibility

Materials

Isopropyl alcohol, reagent, 500 mL*
Sodium chloride, 100 g*
Water, distilled or deionized
Balance, 0.1 g precision
Bottle with cap, plastic, 1 L*
Forceps, large
Funnel
Graduated cylinder, 500 mL, 2
Green marker*

*Materials included in kit.

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 g 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 400 mL of isopropyl alcohol to the bottle.
5. 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, completing questions 1–4 on the Colorful Salting Out worksheet.
2. Uncap the bottle and add the marker.
3. Recap the bottle and shake vigorously.
4. Uncap the bottle and remove the marker before recapping it (you might find it useful to have forceps on hand to remove the marker).
5. Have the students write down their observations.
6. Shake the bottle vigorously to completely mix the two liquids and place it on the table.
7. Once again have students record their observations.

Disposal

The bottle may be reused for many years, although only the first group of students will get to see you adding the marker.

Tips

- This kit contains enough materials to create one demonstration bottle.
- The cap may be glued onto the bottle to prevent opening, spillage or tampering.

Discussion

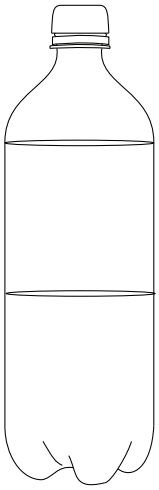
Water and isopropyl alcohol are miscible liquids that form strong hydrogen bonds. When sodium chloride is added to the solution, the ionic solid dissociates. The ions attract the water molecules and disrupt the hydrogen bonds between the water and isopropyl alcohol molecules. As two liquid layers separate, 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 pigments in the marker have different chemical structures and polarities. The polar blue pigment interacts positively with the polar sodium chloride solution and is primarily found in this region. Whereas, the non-polar yellow pigment is primarily found in the less polar isopropyl alcohol/water layer.

When the bottle is shaken, a nearly homogenous mixture of isopropyl alcohol and sodium chloride solution is formed, this type of homogeneous mixture is known as an emulsion. The emulsion recombines the two pigments and the original green color of the marker is observed. After the bottle is set down the emulsion starts to separate back into the two separate layers with the yellow layer on top and the blue layer on the bottom.

Answers to Discussion Questions *(Answers will vary.)*

1. Draw a diagram of the bottle and its contents as presented by your instructor.



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. How can you infer from your diagram which is denser?

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

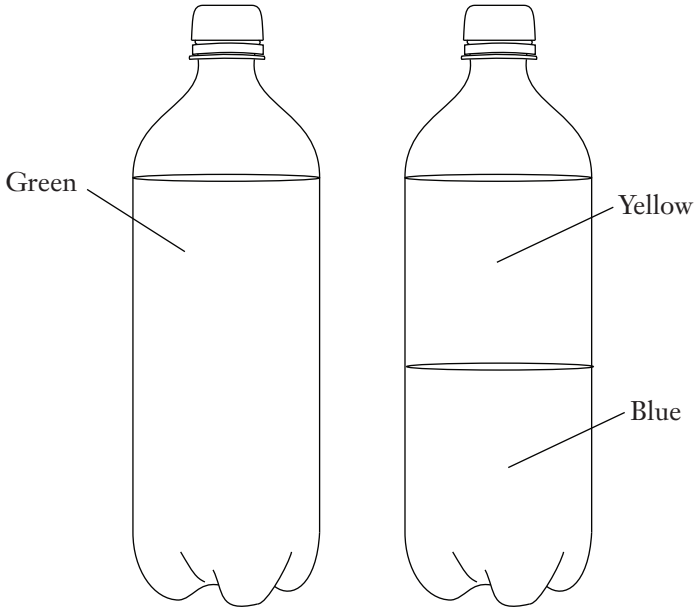
3. Predict what will happen after the marker is added to the bottle.

   When the marker is added to the bottle the color of the layers will change. The top layer will turn yellow, and the lower layer will turn blue.

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

   When the bottle is shaken the two colored layers will form and green emulsion. On standing they will separate back into the two different colored layers.

5. Draw diagrams of the bottle immediately after it was shaken and long after the bottle was shaken.

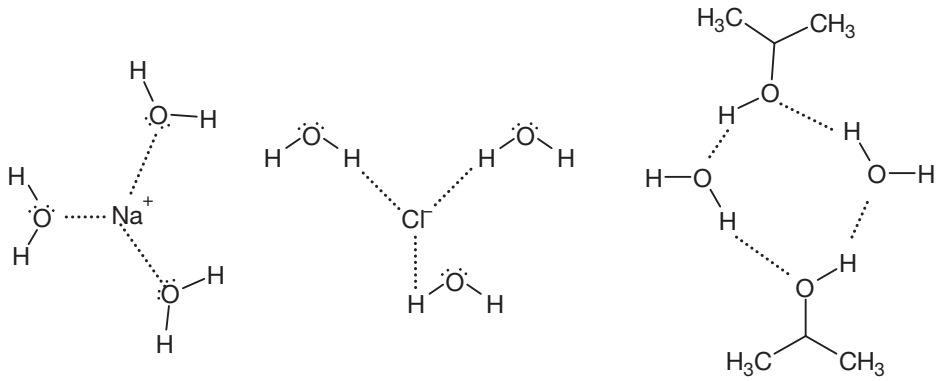


6. Write a possible explanation for what happened when the bottle was shaken and set back down.

   When the bottle was shaken, the isopropyl alcohol and sodium chloride solution mixed completely, making a temporary homogenous solution of uniform polarity. This combined the two colored pigments to give a green solution. On standing, the two layers separate and the pigments are again found in the layers that the result in the strongest intermolecular forces.

7 (*Optional*) 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 *Isopropyl alcohol in water*



Ion–dipole interactions *Hydrogen bonding interactions*

8. (Optional) Based on previous answers, which colored pigment do you think is the most polar.

   The lower layer, containing the sodium chloride solution, is the more polar of the two. Since this layer is blue, and the upper layer yellow, it is reasonable to conclude that the blue pigment is more polar than the yellow.

Acknowledgment

Special thanks and acknowledgement to Kathryn Robles, Troy High School, MI for her assistance in the development of this demonstration.

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

Catalog No.	Description
AP9831	Colorful Salting Out—Chemical Demonstration kit
OB2138	Flinn Scientific Electronic Balance, 300 x 0.1-g

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

Name: _____

Colorful Salting Out

Discussion Questions

1. Draw a diagram of the bottle and its contents as presented by your instructor.

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. How can you infer from your diagram which is denser?

3. Predict what will happen after the marker is added to the bottle.

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

5. Draw diagrams of the bottle immediately after it was shaken and long after the bottle was shaken.

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

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

8. (Optional) Based on your previous answers, which colored pigment do you think is the most polar.