Poly Density Kit

DEN-460

When a 1 L bottle is shaken, the blue and white beads mix within the liquid as expected. However, when allowed to settle, the beads begin to separate: white beads at the top and blue beads at the bottom. Shortly, the two separated colored beads slowly come together until they meet in the center of the liquid, white floating on top of blue. It is curious to see beads floating halfway in a liquid. The mixing and separating can be observed over and over.

Please note: Rubbing alcohol is available in both 70% and 91%. Both are acceptable, but it is critical that you follow the correct procedure for the type of alcohol that you are using.

Preparation using 91% isopropanol:

1. Remove the cap from the bottle containing extremely pure salt (NaCl), and both the white and blue beads.
2. Add 400 ml of clean water, and recap. The water level will be about 11 cm (4.25 in.) from the bottom of the bottle. Shake for several minutes until the salt dissolves.
3. Add 450 ml of 91% rubbing alcohol (isopropanol), and tightly recap. The liquid level will now be about 19 cm (7.3 in.) from the bottom of the bottle.

Preparation using 70% isopropanol:

1. Remove the cap from the bottle containing extremely pure salt (NaCl), and both the white and blue beads.
2. Add 265 ml of clean water, and recap. The water level will be about 7.25 cm (2.85 in.) from the bottom of the bottle. Shake for several minutes until the salt dissolves.
3. Add 585 ml of 70% rubbing alcohol (isopropanol), and tightly recap. The liquid level will now be about 19 cm (7.3 in.) from the bottom of the bottle.

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Explanation

Water and isopropanol are soluble in all proportions; they are miscible. Both the water molecules and the alcohol molecules have -OH groups that easily hydrogen bond to each other.

However, the sodium chloride salt particles, Na^{1+} and Cl^{1-}, preferentially bind with the water molecules, forcing the alcohol molecules out of the water solution. This causes two layers to form: alcohol on top and the more dense water and salt layer on the bottom. Isopropanol and salt water are immiscible; they do not mix in all proportions. This 'salting out' technique is commonly used to remove organic molecules from an aqueous solution.

When the bottle is shaken, the two liquid layers momentarily mix, forming a pseudo homogenous mixture with a density between the two separate liquid densities. The white beads with a lesser density than this liquid mixture float on top and the blue beads with a greater density sink to the bottom.

Then, as the aqueous salt layer separates from the alcohol, the blue beads rise in the bottom aqueous layer and the white beads sink in the top alcohol layer until they meet in the center. From lowest density to highest density, the order is as follows:

isopropanol

white beads

blue beads

salt water

Because the beads float between the two liquids, the actual alcohol/salt water interface is difficult to observe, adding to the mystery. Order spontaneously forming from disorder is unexpected and gives the illusion of a violation of the Second Law of Thermodynamics.

Watch our video online!

https://youtu.be/8YsRgxDonTA

NGSS Correlations

Our Poly Density Kit and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

K-ESS2-1
Students can use and share observations of local weather conditions to describe patterns over time. Students can apply knowledge gained from the demonstration to understand the power of air pressure and its effects on weather.

2-PS1-1
Students can use the Poly Density Kit in an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2
Students can analyze data obtained from testing the Poly Density Kit to determine which materials have the properties that are best suited for an intended purpose.

5-PS1-1
Students can use the Poly Density Kit in an investigation to develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3
Students can make observations and measurements of the different materials in the Poly Density Kit to identify materials based on their properties.

Middle School

MS-PS1-1
Students can use the Poly Density Kit in an investigation to develop models to describe the atomic composition of simple molecules and extended structures.

High School

HS-PS1-1
Students can use the Poly Density Kit in an investigation to predict properties of elements. Students can use the Periodic Table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS2-6
Students can use the Poly Density Kit in an investigation to communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

TeacherSource.com/lessons

Check our blog for classroom-tested teaching plans on dozens of topics:

http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

Density Sphere Experiment Kit (DEN-10)
This awesome kit is designed to permit students to discover and apply concepts of density and buoyancy. In this kit students make a density gradient from sugar or salt in a plastic column. Students then float five small spheres of different densities in the solution. Each sphere floats at a different level! By manipulating the density gradient, students can change the level at which the spheres float.

Mixture Separation Challenge (MIX-100)
Using only table salt and water, students are asked to develop a method for separating this mixture of four different small plastic beads. Advanced students can continue on to determine the density of each different polymer! The material in this separation lab can be used over and over again, and because only polymer materials are used, cleanup is as easy as ever.

Steel Sphere Density Kit (DEN-350)
Great for teaching the skills of observation and deduction! Although these two shiny, metal spheres have about the same mass, one has a diameter significantly smaller than the other, making their densities vastly different. Seeing the large one float in water seems unbelievable!

Density Paradox (DEN-300)

This is an awesome discrepant event for your most advanced 'density' students! When this solid object is placed in water, it initially sinks. Wait about 60 seconds, and it mysteriously floats to the surface. When removed and placed in different water, it continues to float initially and, in about 60 seconds, mysteriously sinks. Why? How can this be? Great for demonstrating how temperature can affect an object's density! In the experiment described above, the first beaker contained hot water from the tap; the second beaker contained ice water. Set of two.