

Dynamics and Statics

Polydensity Bottle

(Ireland)

Background

There are a number of versions of this demonstration available online, but the inspiration for this demonstration comes from the magazine Chemistry In Action (Issue 110, pp.30-31)

Using two colourless liquids of differing density and craft beads of two different densities an enclosed density model can be made that allows teachers to pose a variety of questions about relative densities.

You will need....

- ✓ 1 litre soft drinks bottle
- ✓ 400 cm³ of propan-1-ol (rubbing alcohol)
- ✓ 400 cm³ deionised/distilled water
- ✓ 100g sodium chloride (or kosher salt but not table salt)
- ✓ 100 Pony craft beads of a single colour (lower bead layer - acrylic)
- ✓ 100 Hama/Perler beads of a different single colour (upper bead layer - polyethene)

Follow these steps:

1. Place the propan-1-ol and deionised water into the empty bottle and shake until mixed.
2. Add the 200 g of sodium chloride and shake until fully dissolved.

Upon settling it will be possible to observe a water alcohol layer sitting on a saltwater layer.

3. Add both sets of beads; they will form two layers at the interface of the liquids.
4. For students "Why are the plastic beads sitting in the middle and not floating at the top?", followed by "If there are two layers of colourless liquids in this bottle does that help explain why the beads float the way they do?"
5. If the bottle is now shaken the liquid layers mix temporarily and the beads move quickly to the top and bottom of the bottle.
6. For students: "Why did the beads shoot to the top and bottom after shaking? And why did they return to their start positions?"
7. Within two minutes the layers separate out and the beads return to their original positions.

So what happened?

Water is a polar solvent so will accept propan-1-ol alcohol

and sodium chloride as solutes forming solutions. But as sodium chloride is more ionic than propan-1-ol two liquid layers form. The alcohol layer retains some water.

The Pony beads float in saltwater, so form the lower layer of beads. The Hama/Perler beads sink in the alcohol solution so form the upper bead layer.

When shaken, an emulsion of the two liquids is formed, this has a density between the densities of the two liquid layers. The Pony beads sink to the bottom and the Hama/Perler beads rise to the top. As the layers separate the beads move back to their initial positions, (see the table)

What next?

- This demonstration can be flexibly used at JC, TY or LC Physics levels
- It can be set as a revision demonstration or extension exercise.
- Solubilities and ionic strengths are topics in LC Chemistry that can be explored with this model also.

