

Polydensity bottles

Education in Chemistry

September 2018

rsc.li/2MZkp8Y

Kristy Turner

This activity accompanies the article *What a waste!*: rsc.li/2MZkp8Y

Background

Mixtures of polymers are troublesome for recycling. Householders are not keen to separate their recyclable materials beyond simple classifications like metals, glass and plastic.

Polydensity bottles are highly interactive demonstration pieces. You can use them to help students use scientific thinking to draw conclusions about density and to apply this to real world contexts such as separating mixed polymer waste.

Making the bottles

Different sizes can be made according to the needs of your class. Once they have been made they will last for many years so can be used time and time again.

For each polydensity bottle you will need:

- A clean 100–1000 cm³ plastic bottle with a secure cap
 - c.100 pony beads in one colour
 - c.100 perler or hama beads in another colour
 - Distilled water (enough to fill half the bottle)
 - 91% isopropyl alcohol (enough to fill half the bottle)
 - Salt (sodium chloride free from impurities eg pickling salt)
 - Measuring cup
 - Weighing scales
 - Pouring funnel
 - Spoon
1. Measure out the distilled water.
 2. Add 28 g sodium chloride per 125 cm³ of distilled water and stir until dissolved.
 3. Pour the salt water into the bottle until it is c.40% full.
 4. Pour an equal volume of 91% isopropyl alcohol into the bottle until the bottle is 80–90% full.
 5. Seal the bottle and invert to mix the two liquids, then let them rest and separate.
 6. Open the bottle and add pony beads until there is a 1 cm thick layer of beads where the two liquids meet.
 7. Add perler beads until there is a layer the same thickness as the layer of pony beads.
 8. Seal the bottle.

This [guide to mystery bead bottles](#) also contains detailed instructions and a video.

Using the bottles

Students gently shake the bottle then let it rest. The pony beads sink and the perler beads float to the top. After a few seconds, the pony beads rise and the perler beads sink until they meet at the middle.

Solutions to the student questions

1. Look at your first sketch, state the order of density of the four components of the bottle
Most dense → least dense: brine > pony beads > hama/perler beads > isopropyl alcohol
2. When the bottle contents are mixed and the bottle set down (step three), there are five components in the bottle. What is the new component?
The new component is a mixture of isopropyl alcohol and brine.
3. State the order of density of the five components present at step three.

Most dense → least dense: brine > pony beads > mixture > hama/perler beads > isopropyl alcohol

4. Why does the new component gradually disappear?
The brine and isopropyl alcohol are immiscible. The mixture is a temporary suspension and the brine and isopropyl alcohol quickly separate.

5. When we recycle we mix together many different types of polymers in our 'plastics' recycling bin. Using the concepts you have worked with in this exercise, discuss how density could be used to help separate mixed plastic waste.
Responses to this will vary. In general, ideas about using different liquids and solutions in which some polymers sink and others float in order to separate particular polymers are along the right lines. Discussion about cutting the polymer samples to the same size is also important.