

# The Mysterious Density Bottle

Can be purchased under the name "Poly Density Kit" through Educational Innovations item #DEN-460 at <https://goo.gl/bicBr1>

If you would prefer to make your own, keep in mind that it requires some trial and error; which is science in a nutshell, so as a science educator, you should be used to that, so why am I even bringing it up? Anyway, I found the following procedure on the internet and it works pretty well with a little trial and error.

## Materials:

16 oz bottle

35 g pure (pickling) salt (not iodized or sea salt)

250 ml 70% isopropyl alcohol

140 ml distilled water

UV sensitive pony beads

(<https://goo.gl/3mp7UG>)

Regular pony beads (any craft store)

## Procedure:

Pour the salt and water into the bottle and replace the cap. Shake the bottle until dissolved (go ahead and dance a little...you know you want to). Add both types of beads (the amount is totally up to you, the more you add, the thicker your bead layers will be). If your beads sink to the bottom, don't panic. Add salt a little at a time until they float to the top of the salt water layer (this gives you more opportunities for shaking and dancing). Add the alcohol. The beads should stay in the center of the bottle, disguising the line between the salt water and the alcohol. If the beads float to the top, then you need slightly less salt and you will have to start over (this is the whole trial and error part I was talking about earlier). Why might this happen? Because, different brands of salt have different levels of purity AND salt from different regions also has different levels of purity.

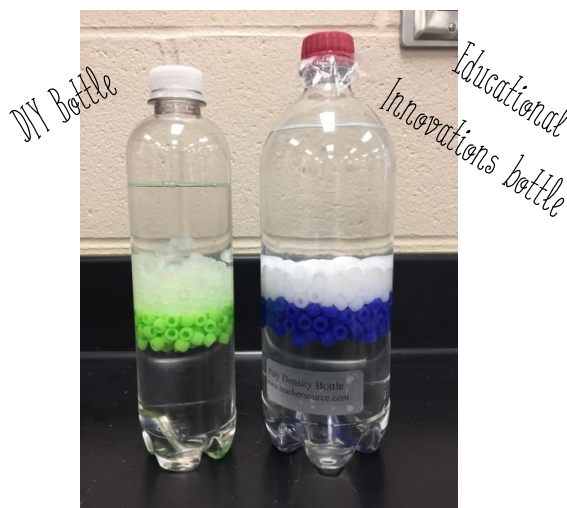
## The Science

When you shake the bottle, a homogeneous-ish mixture is formed temporarily. Then, the white beads rise to the top of the bottle and the blue beads sink to the bottom of the bottle.

**WHY?** The alcohol and salt water layers temporarily mix. The white beads are less dense than the alcohol/saltwater mixture, so they rise to the top. The blue beads are more dense than the alcohol/salt water mixture, so they sink to the bottom.

The white bead layer begins to sink and the blue bead layer begins to rise until the bead layers meet in the middle.


**WHY?** The alcohol/salt water mixture begins to separate. The alcohol, being the least dense of the 4 substances in the bottle, rises to the top. The white beads, being more dense than the alcohol, sink below the alcohol layer. The salt water, being the most dense of the four substances in the bottle, sinks to the bottom of the bottle. The blue beads, being less dense than salt water, rise above the salt water layer. The two bead layers eventually meet in the middle. The beads are made of two different types of plastic, the UV beads (white) are less dense than the regular pony beads, so they form a layer on top of the regular (blue) pony beads. 🍷



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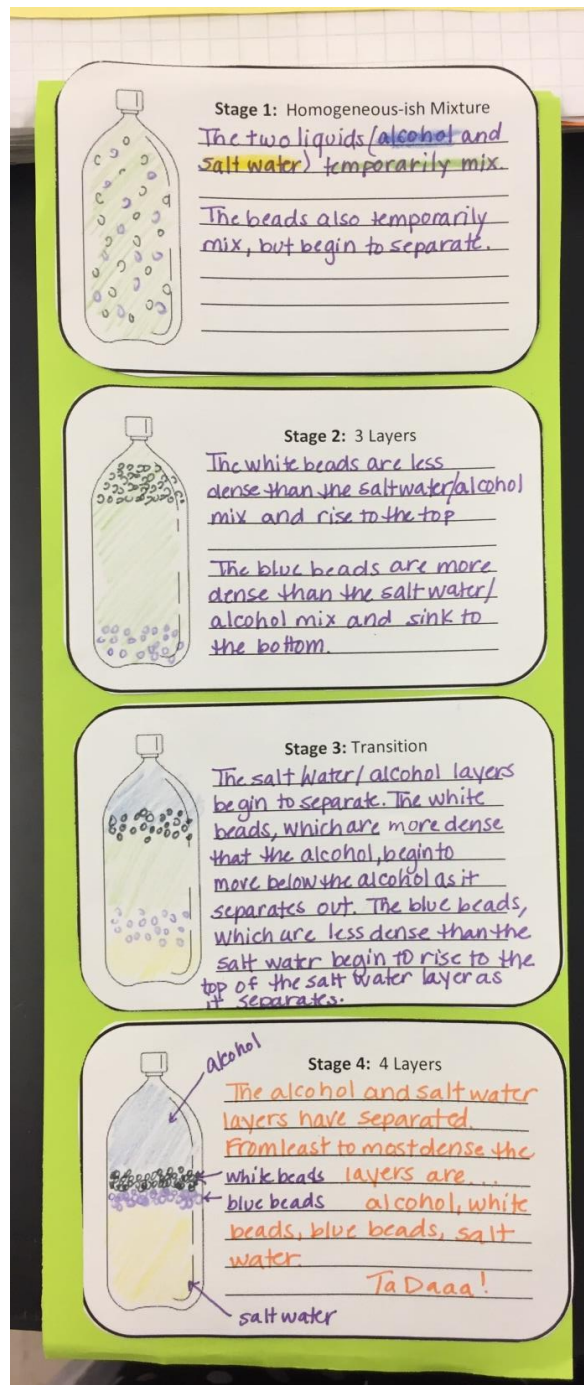
## How do I use this in my classroom?

My 9<sup>th</sup> grade students have studied density conceptually and mathematically (at a basic level) starting in elementary school. In 9<sup>th</sup> grade, according to the Ohio Academic Content Standards, they should be able to determine the density of a substance by finding the slope of a trendline on a mass vs. volume graph. Before we jump right into the whole “scatter plot with a trendline” thing, I like to do an “advanced conceptual review” using the density bottle.

- I give the students the “Density Note Sheet” and run through a brief review of the basics with them. Most of the time, they have a pretty good grasp on the basics of density. Then I hand out the “Mysterious Density Bottle Think Sheet.” I shake up the density bottle and let them observe what happens. I do the demo a number of times and have them fill out the sheet individually. Then, I have them get with a partner or a small group and answer the questions and record their “group answers.” I have them share out their group answers to the questions.
  - Then, I give them the “Density Bottle-Conceptual Understanding” worksheet. The worksheet tells them that there are four substances in the bottle. It is at this point that you can go in a number of directions depending on your time constraints.
  - (This is what I do) I explain how the density bottle works, have the students sketch, and explain each “stage” in terms of density. I break the bottle down into 4 stages. . .
    - **Stage 1: Homogeneous-ish Mixture:** this is when you shake the bottle up and all of the components mix together.
    - **Stage 2: 3 layers:** this is when the UV beads are at the top and the colored beads are at the bottom and the mixture of alcohol and salt water is in the middle.
    - **Stage 3: Transition:** This is when the bead layers start moving toward the center and the alcohol and salt water layers begin to separate out. There are 5 layers in this stage-alcohol, UV beads, alcohol/salt water mix, colored beads, salt water.
    - **Stage 4: 4 layers:** The alcohol and salt water have completely separated and the beads have moved to the center of the bottle at the boundary between salt water and alcohol.
  - You could explain how the density bottle works and have the students take notes and sketch as they follow along.
  - You could continue to have them work in groups and, with the information given at the top of the worksheet, and have them describe what is happening at each stage of the bottle and sketch (either individually or as group)
  - You could blow up the worksheet or display it on a smart board or projector and fill in the worksheet as a whole class.
  - And many other variations!
- I collect and grade their explanations to determine mastery. Then, I have them cut out their sketches/explanations and glue them in their interactive notebooks. 

# The Mysterious Density Bottle

Completed Example



Name: \_\_\_\_\_

**Chapter 2: Matter**  
Properties of Matter-Density  
The Mysterious Density Bottle-Think Sheet

1. Observe the bottle. Describe what happens.
  
  
  
  
  
  
  
  
  
  
2. Why do you think the position of the beads changes?
  
  
  
  
  
  
  
  
  
  
3. How many substances do you think that the bottle contains?
  - a. What is your evidence?

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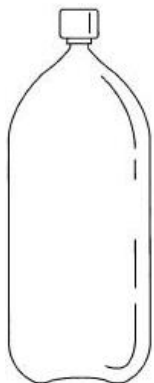
## Chapter 2: Matter

### Density Bottle-Conceptual Understanding

#### Learning Targets:

- ...explain that substances that are more dense than the substance they are in sink.
- ...explain that substances that are less dense than the substance they are in float.

Observe the Density bottle; more than once, if necessary. In the density bottle there are four different substances: two different types of plastic, isopropyl alcohol, and salt water. Using colored pencils, sketch the different stages of the bottle. Explain what is happening, in terms of density, to each substance during each stage. Be specific.



#### Stage 1: Homogeneous-ish Mixture

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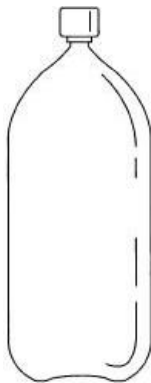
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#### Stage 4: 4 Layers

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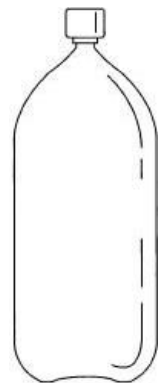
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#### Stage 2: 3 Layers

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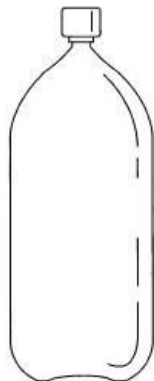
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#### Stage 3: Transition

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Name: \_\_\_\_\_

## Chapter 2: Matter

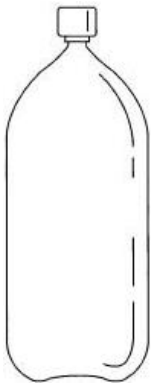
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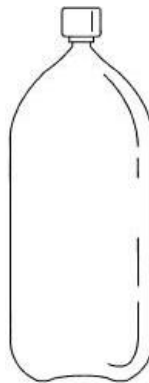
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#### Stage 1: Homogeneous-ish Mixture



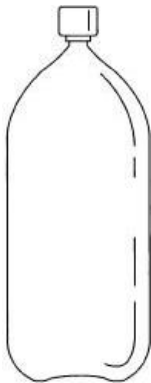
- The alcohol, salt water, blue beads, and white beads mix together in a semi-homogeneous mixture.

#### Stage 4: 4 Layers



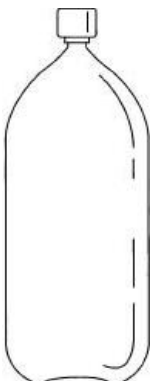
- The alcohol/saltwater mixture has separated.
- Alcohol is the least dense of the 4 substances, so it sits at the top of the bottle.
- The white beads, are more dense than the alcohol, but less dense than the blue beads, so they sit below the alcohol and above the blue beads.
- The blue beads are more dense than the white beads and less dense than the salt water so they sit below the white beads.
- Salt water is the most dense of the four substances, so it sits at the bottom of the bottle

#### Stage 2: 3 Layers



- The alcohol and the salt water have mixed.
- The white beads are less dense than the alcohol/saltwater mixture so they rise to the top of the bottle.
- The blue beads are more dense than the alcohol/salt water mixture, so they sink to the bottom.

#### Stage 3: Transition



- The alcohol/salt water mixture starts to separate.
- The alcohol begins to rise to the top of the bottle; as it rises, the white beads sink, because they are more dense than alcohol.
- The salt water begins to sink to the bottom; as it sinks, the blue beads rise, because they are less dense than the salt water.

## Chapter 2: Matter

### Density

#### What is density?

**Math Definition:** Amount of mass in a given volume

$$\text{Density} = \text{mass/volume}$$

**Review: Mass:** amount of matter in an object

Measured in grams (g)

**Volume:** amount a space an object occupies.

Measured in liters or ml for liquids  
and  $\text{cm}^3$  for solids

**Example:** If you were given a rock with a mass of 243.5g and a volume of  $94.3 \text{ cm}^3$ . What would be the rock's density?

$$D = \frac{\text{mass}}{\text{Vol}} = \frac{243.5 \text{ g}}{94.3 \text{ cm}^3} = 2.6 \text{ g/cm}^3$$

**Particle Definition:** A measure of how tightly matter is packed.

#### Why do objects float or sink?

**NOT** because they are "light or heavy"

But because they are more dense (sink) or less dense (float) than the liquid they are in.

**Example:** The density of water is  $1.0 \text{ g/cm}^3$ . Anything that has a density less than  $1.0 \text{ g/cm}^3$ , will float. Anything that has a density more than  $1.0 \text{ g/cm}^3$  will sink.

Liquids sink and float also.

**Example:** Oil will sit on top of water because oil is less dense than water.

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