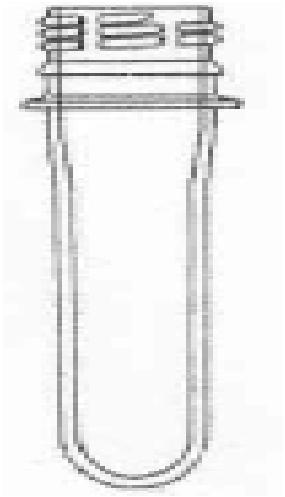
POLYDENSITY TUBES®:
Serious fun with a dense subject

➜START HERE: Your "tube" already has two kinds of plastic pellets.
One color is pieces of POLYETHYLENE TEREPHTHLATE [PET] recycle code #1.
The other color is POLYPROPYLENE [PP] recycle code #5, or LOW DENSITY POLYETHLYENE, [LDPE] #4, or HIGH DENSITY POLYETHYLENE [HDPE] #2.

NOW, DO THIS:

1. Pour in rubbing alcohol until the preform is just over HALF full.
Cap and shake the mixture.



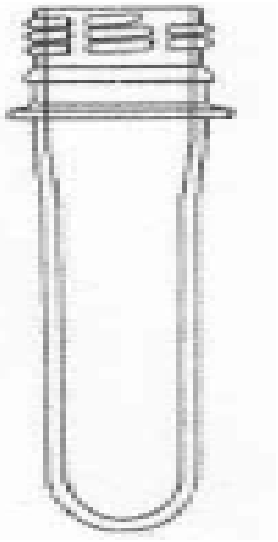
2. Stop shaking, observe, sketch, speculate . . .

least dense component _____

middle density component _____

most dense component _____

3. Add water until the preform is >3/4 full.
Shake, Observe. Sketch. . .



least dense component _____

middle density component _____

most dense component _____

Use the information on the back to come up with an explanation.
AFTER you've finished this page, get the next page. .

Household plastics, from <u>least</u> dense to <u>most</u> dense:

Recycle code	Density in g/mL	Symbol	Name
isopropyl alcohol	0.86	C_3H_7OH	2-propanol
rubbing alcohol	0.88	water in alcohol	70% isopropyl alcohol
5	0.90-0.91	PP	polypropylene
corn oil	0.92-0.93		Not a plastic
4	0.92-0.94	LDPE	low density polyethylene
2	0.95-0.97	HDPE	high density polyethylene
water	1.00	H_2O	Not a plastic
6	1.05-1.07	PS	polystyrene
salt water	~1.2	NaCl(aq)	saturated salt solution
3	1.16-1.35	PVC	polyvinyl chloride [in film form]
1	1.38-1.39	PET(E)	polyethylene terephthalate

I---------"Floaters"----------I I-------"Sinkers"-------I

5PP-4LDPE-2HDPE—water---6PS-3PVC-1PET

Thanks to AMCOR for preforms and PET pellets and to EQUISTAR for PP and PE pellets.

POLYDENSITY TUBES® lynhiggins@sbcglobal.net www.polymerambassadors.org

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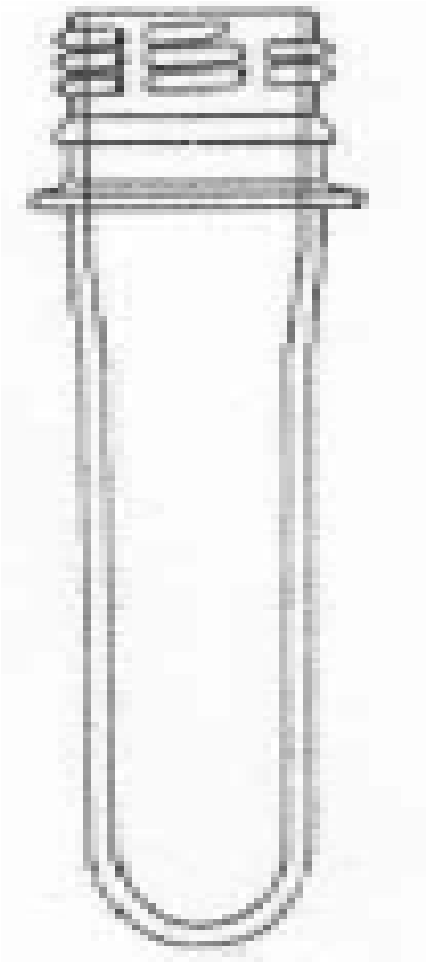
NOW, THE FUN PART . . .

4. Measure about 5 g (1 teaspoon) of canning salt.
   Pour ALL of it into the preform. Cap and shake.
   Shake some more.
   And more. It may take several minutes to dissolve.

5. Observe . . . Keep watching . . .Patience



6. SKETCH the layers you see.

least dense component _____ (l)

middle density components _____ (s)

and _____ (l)

most dense component _____ (s)

HEY, how come those plastics are "floating" in the middle?

HYPOTHESIZE before you look at the explanation on the back.

HERE'S WHY: Propanol (Rubbing alcohol is 70% propanol in water.) dissolves easily in water. Because of "hydrogen bonding" between the very polar water molecules and the somewhat polar 2-propanol molecules, the alcohol is soluble in water in all proportions. Propanol and water are "miscible" in each other.

HOWEVER, 2-propanol is NOT soluble in a NaCl solution.

WHY? Salt, sodium chloride, is an ionic compound. In water, it dissociates into sodium cations + and chloride anions ---.

These ions are strongly attracted to the oppositely charged regions of the polar water molecule: MORE STRONGLY attracted than the alcohol molecules are.

SO, those --chloride ions and +sodium ions sort of "elbow" the alcohol molecules: They push and shove them out of the way.

IN OTHER WORDS, when you add salt to the mixture, the propanol and salt water no longer dissolve in each other. They are "immiscible", and separate into two layers.

The alcohol is less dense than the salt solution, so the alcohol will float on top of the salt-water.

Solids, such as HDPE, LDPE, PP, and PS, which are less dense than salt-water, but more dense than propanol, will float BETWEEN the alcohol and the salt solution.

Because both the liquids are colorless, the interface is difficult to see. It appears that the plastic pieces are "flinking" in the middle of a test tube full of water. BUT THEY AREN'T: Look carefully and you can see a faint white cloudiness at the interface where the alcohol and salt-water meet.

THANK YOU to Barbara Walker and to Dr Chang of Iowa State for the explanation of the "salting out" of alcohol by salt. It's a technique used by generations of biochemists. .

POLYDENSITY TUBES®

TEACHER NOTES

I can't tell you strongly enough to try this with the EXACT components you plan to use. You may be the person to find a polypropylene which floats in propanol. Or some other plastic which doesn't do what you expected.

Use pellets from a Hands on Plastic kit which can be orderd free of charge or obligation from the American Plastics Council website at http://www.teachingplastics.org. OR, Try various kinds of plastic beads from a craft store. I've had interesting results with the "pony" style beads. Also try the ultraviolet detecting beads from **Educational Innovations. http//www.teachersource.com** OR, Punch circles or cut small chips from plastic bottles, containers and lids until you have a good mix of pieces of plastic.

The clear plastic "preforms" can be bought at **Educational Innovations**, or ask a local soft-drink bottler.

Try coloring the liquid layers with various dyes, stains and food colors. Most McCormick® food colors will tint both layers. Except for yellow food coloring, which tints mostly the water layer. Fluorescein does the same. To tint the alcohol layer, I've had good luck with liquid Yaley® brand candle dyes from a large craft store or http://www.yaley.com/candles/candle_dye.html

EARTH SCIENCE students can model the five major layers of the earth.

CRUST==cut out crustal plates from styrofoam food trays
UPPER MANTLE == 2-propanol
LOWER MANTLE == small pieces of HDPE, LDPE, PS or PP
OUTER CORE == salt-water layer, tinted brown with tea
INNER CORE == dark sand

SEVEN LAYER BOTTLE

Many cooking oils have a density between that of the alcohol and the salt-water layers. By choosing plastics with the appropriate density, you can create a POLYDENSITY bottle with seven layers. The oil and alcohol are very close in density and in polarity. They may take from an hour to a week to separate.

Discourage observers from shaking this bottle.

For example, try;

styrofoam pieces
rubbing alcohol
polypropylene pieces
Mazola corn oil
LDPE or HDPE pellets
saturated salt water
PETE pieces or pellets

I recommend that you begin by mixing just water, alcohol, and salt. Shake it up and allow those two layers to separate.

NEXT, add the pieces of different plastics.

LAST, gently add the Mazola

ENJOY !

(A “less inquiry” version)

POLYDENSITY TUBES®

1. Fill the “tube” about 1/4 full of various plastic pieces.

2. Pour in rubbing alcohol to just over half full. Swirl.

3. Observe, sketch: Note which solids float or sink.

4. Add water until the tube is a little over 3/4 full.

5. Put on the lid and shake the tube.

6. Observe, sketch, speculate . . .

7. Remove lid and add about 5 g (1tsp) of salt.

8. Put on lid and shake the tube, LOTS. It might take a minute for most of the salt to dissolve.

9. Keep watching . . . Keep on watching.

10 Observe, diagram, hypothesize . . .

WHAT’S HAPPENING? This method of separating propanol and water is known as “salting out”. The sodium and chloride ions from salt interfere with the hydrogen bonding between the alcohol and water molecules. Bonding between ions from salt and water is stronger and more favorable than the hydrogen bonding between alcohol and water. As a student observed, “Water will rather hang with the salt ions than with the alcohol.”

TEACHER NOTES for POLYDENSITY TUBES®

The clear plastic "preforms" can be purchased at **Educational Innovations at 1.888.912.7474 or http//www.teachersource.com**

Pellets are from a Hands On Plastics® kit which can be ordered free of charge at the American Plastics Council website at http://www.teachingplastics.org/hands_on_plastics/order/index.asp.

OR, Punch circles or cut small chips from plastic bottles, containers and lids until you have a good mix of pieces of plastic.

OR, Try various kinds and sizes of plastic beads from a craft store. Also try the ultraviolet detecting beads from **Educational Innovations. http//www.teachersource.com**

Kosher salt or canning salt and distilled water can be found in most large supermarkets. [Regular table salt has additives that cause the water layer to be cloudy.]

PROCEDURE:
Fill the preform less than a quarter full of plastic pieces.
Add rubbing alcohol to just over the half full point.
Then add water until the container is barely over 3/4 full.
Start with a teaspoon of salt. Add. Cap the container and shake.
It may take several minutes for the salt to dissolve.
For larger containers, add more salt. You need a saturated salt solution.
There should be just a little bit of undissolved salt at the bottom.