

Density Layers

Stack Up The Liquid

Recommended grades level(s) 11-12

Time Duration: - 50 minutes

Objective(s):

The learner will be able to create gradients and observe the interfaces between each material.

The learner will be able to observe the positions taken by solid objects placed into a density gradient and then estimate the density from its position.

The learner will be able to calculate the densities of several common household fluids.

Materials and/or Resources:

Small test tube

Antifreeze

30 wt. motor oil

Power steering fluid

Transmission fluid

10 ml graduated cylinder

10 ml of mineral oil

100 ml cylinder

10 ml isopropyl alcohol

Ajax laundry detergent

Thumb tack

Aluminum paper clip

Small rubber stopper

Plastic paper clip

Piece of paraffin

Cork

Paper towels

Waste container

Beaker

Funnel/ tubing

Downy fabric softener

Food coloring

Clear Karo

Molasses

Background Information:

Density is mass divided by volume. The measurement of density can be expressed in different units depending upon the situation. Gases are often measured in grams per liter. Most liquids are measured in grams per milliliter.

Since most fluids expand as they are warmed, density does depend on temperature and therefore specific gravity of a substance is often reported instead of density. Specific gravity is the density of the substance divided by the density of water. Since water is very close to 1 gram per millimeter at the usual temperature ranges in which humans live, the specific gravity is usually the same value as the density, but without units.

A more dense liquid will settle below a less dense liquid. This is why petroleum floats on sea water. Liquids of different density will form separate layers unless they are very soluble in each other. It often requires an input of energy such as stirring to cause the molecules to fit between each other, that is dissolve in other. Even solutions of the same compounds but different concentrations will form separate layers and then slowly mix with each other.

Some liquids are not miscible; that is, they do not dissolve in each other. Petroleum does not dissolve in water. Another example is vinegar and oil salad dressing. The dressing can be mixed well but will separate into distinct layers within a few minutes if left undisturbed.

A solid object will float on a liquid if the density of the object is less than the density of the liquid. Ocean liners are metal but will float on water because the volume of the liner is large enough to make its density is less than water. A well known bar soap has enough air whipped into it that its density is less than water so that it floats in the bath.

A solid object in a series of layers of liquids will float in a layer that is of the same density or will float between two layers with densities above and below its own density.

The automobile fluids do not mix well with each other as is shown by the initial layers. Some of these fluids will be slightly miscible while others will be very miscible when mixed. The amount of miscibility depends upon how many alike the molecules are.

Procedures:

1. Pour gently down the side of a small test tube 1 mL each of antifreeze, brake fluid, 30 wt motor oil, power steering fluid, and transmission fluid. Watch as you pour the fluids to see which one goes to which level. Set the test tube aside and wait for the liquids to separate.
2. Weigh a clean dry 10 mL graduated cylinder.
3. Fill the 10 mL cylinder with about 10 mL of mineral oil. Read the volume to two decimal places. Weigh the cylinder and oil.
4. Pour the mineral oil into a 100 mL cylinder.

5. After cleaning and drying the 10 mL cylinder, measure the volume and weight of about 10 mL of isopropyl alcohol. Add several drops of green food color to the alcohol.
6. Using a long funnel or tubing which touches the bottom of the 100 mL cylinder, pour the isopropyl alcohol underneath the mineral oil.
7. Repeat steps 5 and 6 using first Ajax laundry detergent, Downy fabric softener, clear Karo, and finally molasses. Food color need not be added. Each new liquid needs to be gently placed on the bottom of the cylinder. As the liquid becomes more dense, it will take longer for the liquids to drain out of the funnel.
8. Determine the approximate density of a thumb tack, an aluminum paper clip, a small rubber stopper, a plastic paper clip, a piece of paraffin, and a cork by allowing the object to slide gently down the side of the cylinder. Each object will stop at the level of its density or between liquids that are above and below its density.
9. Clean the inside of the top of the auto fluids test tube prepared in step 1 with a paper towel. Insert a rubber stopper snugly. Gently invert the test tube and set it into a beaker. Observe which fluids mix and which form new layers.
10. Pour the auto fluids into a marked waste container. The liquids in the 100 mL cylinder may be mixed together and poured down the drain.

Development Resources:

Hassell, Alton C, Marshall P., Hill J. (1998) Chemical Investigations for Changing Times. 8th ed New Jersey: Prentice Hall Upper Saddle River.