

LIQUID RAINBOW: DETERMINING DENSITY OF DIFFERENT SOLUTIONS



Westminster College

INTRODUCTION

Why do objects that are the same size sometimes have different weights? The answer has to do with their **density**. An object's density is determined by comparing its mass to its volume. If you compare a rock and a cork that are the same size (they have equal volume), which is heavier? The rock is, because it has more mass. The rock is denser than the cork, then, because it has more mass in the same volume - this is due to the atomic structure of the elements, molecules, and compounds that make it up.

Liquids have density, too. You can perform several experiments with different types of liquids to determine which is denser.

The **density** of a material is defined as its mass per unit volume. The symbol of density is ρ (the Greek letter rho).

Mathematically:

$$\rho = \frac{m}{V}$$

Where: ρ (rho) is the density, m is the mass and V is the volume

Different materials usually have different densities, so density is an important concept regarding buoyancy, metal purity and packaging.

A very common instrument for the direct measurement of the density of a liquid is the hydrometer, which measures the volume displaced by an object of known mass. A common laboratory device for measuring fluid density is a pycnometer; a related device for measuring the absolute density of a solid is a gas pycnometer. Another instrument used to determine the density of a liquid or a gas is the digital density meter - based on the oscillating U-tube principle.

The density of a solid material can be ambiguous, depending on exactly how its volume is defined, and this may cause confusion in measurement. A common example is sand: if gently filled into a container, the density will be low; when the same sand is compacted into the same container, it will occupy less volume and consequently exhibit a greater density. This is because sand, like all powders and granular solids contains a lot of air space in between individual grains; this overall density is called the bulk density, which differs significantly from the density of an individual grain of sand.

MATERIALS

Clear transfer pipets
50 mL beaker or small paper cup
Food coloring (optional)

Colored salt solutions, 5
Beaker or cup (filled with water)

PROCEDURE

1. At your lab station, you will find 5 test tubes with different colored solutions, a clear transfer pipet and a cup filled with water. Each of the colored solutions has a different density.
2. Practice drawing up the water into the transfer pipet. It is important that you are able to draw the colored solutions into the pipet at a controlled pace to keep the solutions from mixing.
3. Your instructor will assign your group a color to test. Record this color in the first column of the Individual Data table on the Data Sheet. Your lab group is responsible for determining which solutions are more dense (heavier) and less dense (lighter) than this solution.
4. Carefully draw the assigned colored solution about a third of the way up the transfer pipet.
5. While keeping the first solution in the pipet, select another colored solution. Gently lower the transfer pipet into this solution and slowly draw up the second solution.
6. Place your finger over the end of the pipet and let the two solutions settle. If the assigned solution floats on the second, the first solution is less dense. If the first solution mixes or falls through the second, the assigned solution has a higher density.
7. Record the results in the appropriate column in the Individual Data table. It is best to report the data so that it is clear which solution floated on the other. For example, if you are assigned to test the red solution, and find it floats on top of the clear, you would record this as R/C in the "Clear" column.
8. Discard the two solutions in the waste beaker. Rinse the transfer pipet by drawing water into it 2-3 times.
9. Repeat Steps 4-7 for the other 3 colored solutions, being sure to record the results each time. When you are finished, share your findings with the rest of the class.
10. Your classmates will have tested the density of the other colored solutions. Do not forget to record this information in the Class Data table provided on the Data Sheet.

DATA SHEET

Name: _____
 Group: _____
 Date: _____

DATA ANALYSIS

Individual Data: Comparison of Solution Density					
Assigned Color	Clear	Red	Yellow	Green	Blue

Class Data: Comparison of Solution Density					
	Clear	Red	Yellow	Green	Blue
Clear					
Red					
Yellow					
Green					
Blue					

QUESTIONS

1. What is the order of the densities of the colored solutions?

Least dense -----> Most dense				

2. How did you use the information from the class data to determine the order of the densities?