# Pre-Lab Information

Purpose Conduct an investigation to explore the concept of density, and how densities of liquids and solids compare to each other.

Time Approximately 60 minutes

Question How do the densities of various liquids and solids compare?

Summary In Part I of this experiment, you will calculate the density of five liquids using the mass and volume of each liquid. In Part II, you will use the calculated densities to layer the liquids and create a density column. In Part III, you will predict the locations that three solid objects will take within the density column, and then observe the actual locations. Finally, in Part IV, you will use the data collected in previous parts to estimate a value for the density of a rubber stopper, and then calculate the actual density.

# Safety

* Always wear a lab coat and safety goggles when performing an experiment.
* Behavior in the lab needs to be purposeful.
* Never eat or drink the materials used in a lab experiment.
* Check glassware, such as beakers and graduated cylinders, for cracks and chips prior to use.
* If glass breaks before, during, or after the experiment, inform your teacher.
* Clean up all spills immediately.
* Report all accidents—no matter how big or small—to your teacher.

# Lab Procedure

1. **Gather materials.**

|  |  |  |
| --- | --- | --- |
| * 30 mL molasses * 30 mL water * 30 mL vegetable oil * 30 mL light corn syrup * 30 mL dish soap (blue) * Steel marble | * Rubber stopper * Cork * Food coloring (red, green) * Triple beam balance * Test tube brushes * Paper towels | * Five 10mL graduated cylinders * One 100mL graduated cylinder * One 50mL graduated cylinder * Glass stirring rods * Calculator |

## Part I: Calculating the Density of Five Liquids

1. **Measure the mass and volume of each liquid.**
   1. Place a clean 10 mL graduated cylinder on the triple beam balance and zero the balance.
   2. Add approximately 10 mL of the 30 mL of molasses to the graduated cylinder. Record the volume in Table A.

Note: It is okay if the volume is not exactly 10 mL as long as the volume is recorded accurately.

* 1. Determine the mass of the molasses. Record the mass in Table A.
  2. Using a clean 10 mL graduated cylinder each time, repeat Steps 2a–2c for water, vegetable oil, light corn syrup, and dish soap to complete the “Mass” and “Volume” columns in Table A.

1. **Calculate the density of each liquid.**
   1. Calculate the density of molasses. The formula for density () is mass () divided by the volume ():

Record the density in Table A.

* 1. Repeat the density calculation in Step 3afor water, vegetable oil, light corn syrup, and dish soap and complete the “Density” column in Table A.

## Part II: Creating a Density Column with Five Liquids

1. **Determine the order of liquids for the density column.** 
   1. Use the densities from Table A to determine the order for stacking the liquids within a density column. A density column is a stack of liquids in a tall, thin cylinder.

Note: Consider how liquids will sort based on density. Where should the liquid with the highest density be? Where should the liquid with the lowest density be?

* 1. Record the names and densities of the five liquids in Table B from top to bottom. Your list should be based on where you think the liquid will remain in the density column.

1. **Construct a density column.**
   1. Before creating the density column, add red food coloring to the remaining 20 mL of water and green food coloring to the remaining 20 mL of corn syrup. Use stirring rods to mix the food coloring into the liquid. This will help distinguish them in the density column.
   2. Carefully pour the remaining 20 mL of each liquid into a 100 mL graduated cylinder. Add the liquids in the order you provided in Table B. Liquid 1 should be poured into the graduated cylinder first. Let each liquid settle before adding the next.

## Part III: Using the Density Column to Compare Densities of Solid Objects

1. **Compare the density of solid objects.**
   1. Examine a steel marble, cork, and rubber stopper. Without measuring the mass and volume, consider what each solid’s density might be.
   2. Predict where each solid object will remain when placed in the density column. Record your ideas in the “Predicted Location” column of Table C.
   3. Place the steel marble in the density column. Record your observations in the “Actual Location” column of Table C.
   4. Repeat Step 6c for the cork and rubber stopper. Complete Table C.

## Part IV: Estimating and Calculating the Density of a Rubber Stopper

1. **Predict the density of the rubber stopper.** 
   1. Observe the location of the rubber stopper in the density column. Refer back to the densities of the liquids in the density column.
   2. If the rubber stopper is suspended above a particular liquid, then the density of the rubber stopper is less than the density of that liquid. If the rubber stopper has sunk below a liquid, then the density of the rubber stopper is greater than the density of that liquid. Use these known densities to provide a range of density estimates for the rubber stopper. Record these values in Table D.
2. **Calculate the density of the rubber stopper.**
   1. Remove the rubber stopper from the density column. Clean and dry it.
   2. Measure the mass of the rubber stopper with the triple beam balance. Record the mass in Table D.
   3. Measure the volume of the rubber stopper by using the displacement method. Fill the 50 mL graduated cylinder with 40 mL of water. Add the rubber stopper. Record the volume in Table D.
   4. Calculate the actual density of the rubber stopper and record the value in Table D.
3. **Clean up.**
   1. Dispose of all materials according to your teacher’s directions.
   2. Clean and store all equipment according to your teacher’s directions.

# Data

Record your data in your lab notebook or in the space below.

**Table A. Mass, Volume, and Density of Five Liquids**

|  |  |  |  |
| --- | --- | --- | --- |
| **Liquid** | **Mass (g)** | **Volume (mL)** | **Density (g/mL)** |
| **Molasses** |  |  |  |
| **Water** |  |  |  |
| **Vegetable oil** |  |  |  |
| **Light corn syrup** |  |  |  |
| **Dish soap** |  |  |  |

**Table B. Order of Liquids for the Density Column**

|  |  |  |
| --- | --- | --- |
| **Density Column** | **Liquid** | **Density (g/mL)** |
| **Liquid 5 (top)** |  |  |
| **Liquid 4** |  |  |
| **Liquid 3** |  |  |
| **Liquid 2** |  |  |
| **Liquid 1 (bottom)** |  |  |

**Table C. Locations of Solids in the Density Column**

|  |  |  |
| --- | --- | --- |
| **Solid** | **Predicted Location** | **Actual Location** |
| **Steel marble** |  |  |
| **Cork** |  |  |
| **Rubber stopper** |  |  |

**Table D. Density of the Rubber Stopper**

|  |  |
| --- | --- |
| **Predicted density of rubber stopper** | between \_\_\_\_\_\_\_ g/mL and \_\_\_\_\_\_\_ g/mL |
| **Mass of rubber stopper** | g |
| **Volume of rubber stopper** | mL |
| **Actual density of rubber stopper** | g/mL |

# Follow-Up Questions

Answer the following questions.

1. Which liquid had the greatest density? Which liquid had the lowest density?

2. Which of the solids sank to the bottom of the density column?

3. Did your calculated density match your predicted density? Explain.