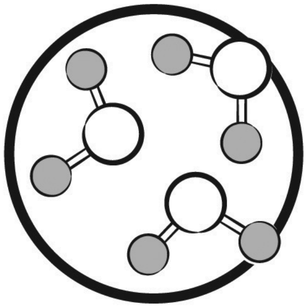


Density Rainbow

Learning Objectives: *Students investigate the concept of density.*

GRADE LEVEL

2–8

SCIENCE TOPICS

Physical Properties
Atoms and Molecules
Solutions and Mixtures

PROCESS SKILLS

Measuring
Predicting
Classifying
Inferring

GROUP SIZE

2–4

SNEAK PEAK inside …

ACTIVITY

Students stack colored liquids in a plastic drinking straw.

STUDENT SUPPLIES

see next page for more supplies

food coloring or Kool Aid™
plastic cups
sugar
clear straws, etc.…

ADVANCE PREPARATION

see next page for more details

Fill and label water bottles
Label cups of sugar, etc.…

OPTIONAL EXTRAS

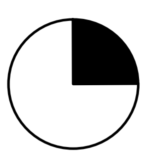
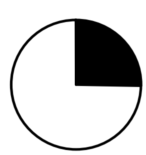
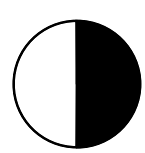
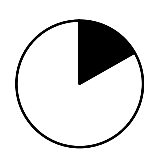
DEMONSTRATION

Modeling the Procedure (p. A - 15)
Make the Solutions (p. A - 15)
Classroom Density—Constant Volume (p. A - 15)
Classroom Density—Constant Mass (p. A - 16)
Sink or Float (p. A - 16)

EXTENSIONS

Mystery Solution (p. A - 23)
Calculating Density (p. A - 23)
Stack of Liquids (p. A - 24)

TIME REQUIRED

Advance Preparation	Set Up	Activity	Clean Up
			
15 minutes	**15 minutes**	**30 minutes**	**10 minutes**

SUPPLIES

Item	Amount Needed
tall, clear, narrow plastic cups (9-oz. or 12-oz.)	5 per group
masking tape	1 roll per group
permanent markers (e.g., Sharpie™)	1 per group
granulated sugar	1 cup per group
teaspoon measure	1 per group
clear plastic drinking straws	1 per student
pop-top squeeze bottles (e.g., water or sports drink) 16-oz or larger	2 per group
food coloring (red, green, blue, and yellow) **OR** sugarless Kool Aid™ packets of the same colors	set of 4 colors per group
access to a sink (cold water works fine)	a total of 3–4 gallons of water is needed

For Extension or Demonstration supplies, see the corresponding section.

ADVANCE PREPARATION

Supplies Preparation

Sugar:

- Fill plastic cups with 1 cup of sugar for each group.
- Label plastic cups "sugar."

Water:

- Fill pop-top squeeze bottles with water, 2 for each group.
- Label bottles "water."

Color:

- Collect small bottles of food coloring (red, blue, yellow and green).
- Instead of food coloring, you can use sugarless Kool Aid™ packets. Dissolve a Kool Aid™ packet in about ¼ cup of water. Do not add sugar.

Sugar Solutions:

- Students mix their own colored sugar solutions according to the Scientific Procedure.
- To avoid messes or to streamline the activity, you may choose to prepare the solutions beforehand or as a whole class activity.

Optional Large Scale Preparation of Solutions (12 cups of water)		
Add ~30 drops of food color	Cups of sugar	Final concentration of sugar in water
Red	¼	1 tsp/cup
Blue	½	2 tsp/cup
Yellow	¾	3 tsp/cup
Green	1	4 tsp/cup

Notes and Hints

- Tall, narrow cups are best since it allows students to put their straws deeper in the sugar solutions, and it is easier to stack the different liquids in the straw.
- If clear straws are difficult to find, try a diner or small restaurant such as Denny's or Wendy's.
- Sugarless Kool Aid™ can also be used to color the solutions (two packets for 12 cups).

SETUP

For each group

- 5 tall, clear, narrow plastic cups (9-oz. or 12-oz.)
- 1 roll of masking tape
- 1 permanent marker
- 2 pop-top squeeze bottles, filled with water
- 1 plastic cup with about 1 cup of granulated white sugar
- 1 teaspoon
- clear plastic drinking straws (1 per student)

At a central location (or with the teacher)

- sponges and towels for clean up
- food coloring, set of 4 colors: red, blue, green, and yellow or sugarless Kool Aid™ packets (teacher can also pre-color the students' water—see Advance Preparation above)

INTRODUCING THE ACTIVITY

Let the students speculate before offering answers to any questions. The answers at right are provided for the teacher.

Choose questions that are appropriate for your classroom.

In this activity, students will make many sugar solutions. Each will have a different density. The less dense solutions will be able to float on the more dense solutions inside of drinking straws.

If we put 100 people in our classroom, how crowded would it be? If we put 100 people in a baseball stadium (or other large area familiar to students) how crowded would it be?
The classroom would be very crowded. The stadium would seem empty.

The Teacher Demonstration "Classroom Density" on p. A - 15 demonstrates this concept directly.

The word scientists use for crowding is density. Something that is very crowded is considered very dense. What are examples of things that are very dense or very crowded? What are examples of things that are not very dense or not very crowded?
Very dense: cities, sardines, the bedroom I share with my two brothers, the playground during recess. Not very dense: farms, the huge house my grandmother lives in by herself, the refrigerator right before we go shopping.

Molecules make up all materials. In any material, the molecules can be very crowded or spread apart. Some materials, like air, have the molecules spread far apart. Some materials, like iron, have the molecules packed close together. In general, all gases (like air) are less dense than all solids (like iron).

Misconception Alert: The "crowding" analogy for density assumes all the objects are about the same weight (e.g., people in a classroom). This analogy works when comparing collections of the same objects, like a class of people on the playground vs. the class in the classroom. However, density is really the mass per volume, so a room with just a few really, really heavy objects (like tractors) could have the same density as a room packed with people.

Some liquids or objects are more dense and sink in water; some are less dense and float on water.
What are examples of objects that sink in water?
What are examples of objects that float in water?
Float in water: wood, boat, styrofoam. Sink in water: steel, rocks, paper clips.

Can you think of liquids that float or sink in water?
Liquids that float on water are motor oil, alcohol, and vegetable oil. Liquids that sink in water are honey, corn syrup, and glue.

CAUTION: Never put lab supplies into your mouth. Even if lab supplies are food, they many be contaminated from other items in the lab.

TEACHER DEMONSTRATION

Modeling the Procedure

Especially for younger students, demonstrate how to hold liquids in a straw. Pictures are included in the procedure. Encourage students to practice filling and sealing a straw.

It is also helpful to demonstrate layering two colored sugar solutions in a straw, as some students may have difficulty interpreting the directions.

Make the Solutions

For younger students, you may wish to make all the solutions as a demonstration in front of the class. Through guided discussion, students can understand that each color of water has a different amount of sugar, and thus a different density.

- Use the recipes given in the table in Advance Preparation.

Classroom Density (Constant Volume)

This demonstration is useful for all grades and models the different sugar solutions the students create during the activity.

- Move desks or chairs to define a space in the classroom. Choose three or four students to enter the space. They represent molecules of plain water. The water molecules have a lot of room to move in the space.
- Choose three or four more students to join in the space. They represent sugar being added to the water. They make the space more dense, since the molecules are more tightly packed in the space.
- Continue to add students until the space becomes very crowded and dense. Students should understand that in a dense substance, there are many particles (corresponding to higher mass) packed in a space (volume).

Explanation

This demonstration mimics what students are doing when they create the different sugar solutions in the activity. They always have the same volume of water (represented by the space in the classroom). In each solution, they are adding a different amount of sugar (represented by the number of students). As students add more sugar, they are creating a denser solution.

Classroom Density (Constant Mass)

This demonstration is better for older students since it demonstrates a concept not seen in the lab activity.

- Move desks or chairs to define a small space in the classroom. Choose five or six students to enter the space. They should be somewhat tightly packed. This represents a dense substance.
- Pull the desks and chairs to create a slightly larger space. Encourage the students in the space to move around a little. This represents a less dense substance.
- Continue to enlarge the space until it takes up most of the classroom. Students should understand that having the same number of particles (mass) in different spaces (volume) would result in different densities.

Explanation

This represents how different substances may have different densities. A Styrofoam peanut and a paper clip may have the same mass (represented by the same number of students), but the paper clip has its molecules more tightly packed. The paper clip is denser than the Styrofoam.

Sink or Float

Use an assortment of small objects and liquids and a container of water to show how some objects float and others sink, depending on their density.

Supplies

- large jar, glass, plastic cup, or aquarium filled with water
- assortment of small objects to test (paper clip, Styrofoam, penny, cork, nail, rock, wood, golf ball, ping pong ball, pencil, eraser, marble, etc.)
- assortment of liquids to test (oil, honey, corn syrup, alcohol) Avoid liquids that will mix with the water.

Demonstration

- Show an object or liquid to students. Ask them to predict whether it will sink or float in the water.
- Test the object or liquid by dropping it into the container of water.

Explanation

Objects and liquids that are denser than water will sink in water. Objects and liquids that are less dense than water will float on water.

Misconception Alert: Many students may make a connection that an item will float if it has air, or that air is necessary to make an object float in water. Using oil or alcohol, which have no air and which float in water, can help students to understand that air is not necessary for something to float.

Misconception Alert: Substances like steel and concrete sink in water, but they can be used to make boats that float on water. This is because the material is spread apart to take up a larger space. This makes the overall structure less dense and it floats.

Have students work in groups of 2–4 and follow the Scientific Procedure, starting on page A - 27. Below are suggestions to help the teacher facilitate the activity.

NOTES

This handout is on p. A - 27.

Density Rainbow

SCIENTIFIC PROCEDURE

1. Label four cups from #1 to #4.
   Label the fifth cup "waste."
2. Half fill cups #1 to #4 with water.
   Add sugar to each cup according to the chart.
3. Add water to cups #1 to #4 to look like the picture.
   Color the water in each cup according to the chart.

Cup	Sugar (spoonfuls)	Color (4 drops)
1	1	red
2	2	blue
3	3	yellow
4	4	green

Running Suggestions

- Students can stir their solutions with the straw to help the sugar dissolve faster. Warm water will dissolve the sugar faster but is not necessary.
- Monitor students to make certain that they have the same amount of water in each cup after they dissolve the sugar.
- To avoid extra mess, you can pre-color the solutions and let the students add sugar. Students will need to trade colored solutions between groups to get all the colors they need. You may want to show students that even though the water is different colors, it all has the same density before the sugar is added.
- Encourage students to lift their fingers SLOWLY off of the straw while it's under water; the layers are less likely to mix that way. **Also make certain that students are putting the straw lower in each successive liquid.**
- Use narrow 8-oz or 12-oz cups if possible. This will allow the straws to be inserted deeper in the water so students can fit all four colors in their straws.
- If students have difficulty seeing the layers of colors in their straw, it may help to hold the straw against a white background.

Ongoing Assessment

- For younger students, ask them to draw and color pictures of the liquids as they layer in the straw. You can also use the data sheet provided on page A - 32.
- Why is it important to have the same amount of water in all the cups? *We want to pack the different masses of sugar into the same volume in the cups, so their densities are easier to compare*.
- What happens if you add the solutions in the reverse order? *This will put a more dense liquid on top of a less dense liquid. They will mix as they try to trade places.*
- What will happen if you turn the straw upside down? *A more dense liquid would be on top of the less dense liquid. They will mix as they try to trade places.*
- How could you find the density of an unknown solution? *Layer the unknown solution over or under those that are known. If it is less dense than the other solution, it will float. If it is more dense than the other solution, it will sink.*

Safety and Disposal Information

- All liquids can be poured down the sink or saved in a large container for later disposal.
- Cups and straws can be rinsed and re-used or thrown away.

CAUTION: Never put lab supplies into your mouth. Even if lab supplies are food items, they may be contaminated by other items in the lab.

CLASSROOM DISCUSSION

Ask for student observations and explanations. Let the students guide the discussion and present their hypotheses before discussing explanations.

Choose questions that are appropriate for your classroom.

Which liquid is most dense? (Which sank?) Why?
The one with the most sugar. This liquid had the most mass packed into a space.

Which liquid is least dense? (Which floated on all the other liquids?) Why?
The one with no sugar, or the one with the least sugar. This liquid had the least mass packed into a space.

What other materials could you do this experiment with?
Oil, corn syrup, salt water, alcohol, etc.

Will the layers stay separate, or will they eventually mix?
The layers will eventually mix, because the sugar molecules will travel to other layers, so the solution will eventually have the same density all the way through.

The colored liquids each have a different amount of sugar dissolved in a cup of water. When students start with the less dense liquid on top of the more dense liquid, they don't mix. When students add liquids out of order, a less dense liquid is below a more dense liquid. The less dense liquid wants to float, and the more dense liquid wants to sink. So the two liquids mix as they try to switch places.

EXPLANATION

This background information is for teachers. Modify and communicate to students as necessary.

In this activity, students create different solutions of sugar water. They compare the ability of these liquids to sink or float on each other.

BACKGROUND FOR ALL GRADES

All matter is made of **atoms.** Atoms combine to make **molecules**. Atoms and molecules are too small to see, but, together, they make up all substances. To find out how much matter is in a substance, scientists weigh the substance to determine its **mass**. The more matter a substance contains, the more mass it has.

Density

When sugar **dissolves** in water, the molecules of sugar separate from each other and become completely surrounded by the water molecules. When more sugar dissolves in water, there is more matter packed into the same space. This makes the liquid denser.

In this activity, students create different solutions, each with a different amount of sugar in the same amount of water. As more sugar is added, more matter is squeezed into the same space. This increase in matter in a given space causes an increase in **density**. Density is a measure of the amount of matter packed into a space. Density increases when the amount of matter goes up (Figure 1) or when the space it is packed in goes down (Figure 2). In this exercise, students increase density by packing in more matter (i.e., sugar).

More molecules → More packing → More dense

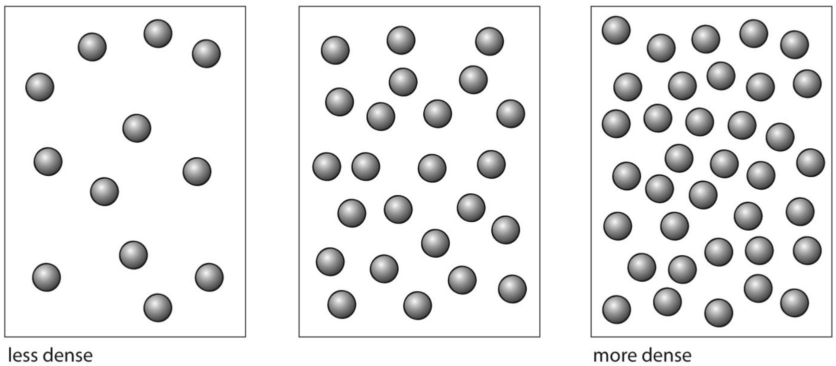


Figure 1. Each square is the same size, but has an increasing number of molecules (12, 24, and 36 from left to right).

Loosely packed spaces are less dense than highly packed spaces.

Less space → More packing → More dense

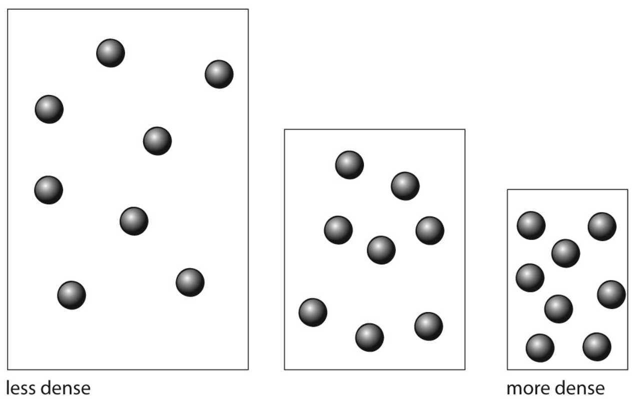


Figure 2. These rectangles all contain 8 molecules, but they are packed into smaller and smaller spaces.

As the molecules are packed more closely together, the rectangle becomes more dense.

Sink or Float?

The concept of density explains why things sink or float in water. If a solid (like wood) is less dense than water, it will float on the water—regardless of the weight. For instance, pianos float on water, even though they are very heavy, because they are less dense. On the other hand, solids that are more dense (like metals) will sink in water. Even a piece of metal as light as a dime will sink in water because the metal is more dense.

Liquids work the same way. Those that are less dense will float on top of those that are more dense. For example, oil floats on water because oil molecules are not as tightly packed (i.e., not as dense) as water molecules. Just as with pianos and dimes, the total amount of the water and oil doesn't matter—if someone pours a can of oil on the bottom of a swimming pool and then fills the pool with water, the oil will still float on top.

In the same way, the molecules in honey are more tightly packed than the molecules in water, so honey will sink in water. (It eventually dissolves in water, though, and becomes evenly dispersed throughout the solution.)

Population Density

Population scientists and **demographers** describe the population density of cities, states, or countries. These scientists use the number of people living in a square mile of an area. Higher density urban areas have a larger number of people per square mile; lower density rural areas have a smaller number of people per square mile. The people are more tightly packed in densely populated areas.

EXTRA BACKGROUND FOR GRADES 5–8

Mathematics of Density

In addition to these general descriptions about density, it is possible to measure and then calculate a substance's density. To find a numerical value for the density of a substance, we measure the **mass** of the substance (how much matter it contains) and the **volume** of the substance (how much space it fills).

Dividing the mass by the volume gives the **density** of the substance:

$$\textbf{density} = \frac{\textbf{mass}}{\textbf{volume}}$$

Using the metric system, mass can be measured using grams (g) or kilograms (kg). Volume is measured using milliliters (mL) or liters (L). Therefore density is expressed as a ratio of mass to volume: for example, grams per milliliter (g/mL) or kilograms per liter (kg/L).

We can apply this same method of measurement to the Figure 1 in the previous section to give numerical descriptions for their density. Let's assume each molecule weighs 1 gram and that each box is 1 liter (not true, but it makes for easy calculations). For each picture, the density is calculated by taking the mass (12 grams) and dividing by the volume (1 liter). For example, the first box in Figure 1 has a density of 12 grams per liter.

A Density Surprise

Because density is defined as mass per space, some "less packed" arrangements of molecules can actually be as dense as more tightly packed arrangements, as long as the individual molecules are each much heavier. Consider Figure 3 that shows three boxes with equal density. Because the molecules are heavier in the first box, it has the same density as the more packed arrangement of the third box.

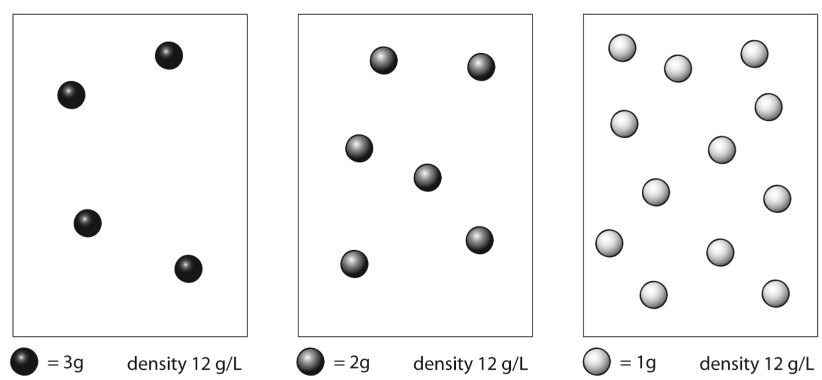


Figure 3. Each box has the same volume (1 L) and contains the same mass (12 g), so they each have the same density (12 g/L).

Density of Water
The density of water is 1 gram per milliliter (1 g/mL). This means that one milliliter of water weighs one gram. Substances that have a density greater than water (greater than 1g/mL) will sink in water. Substances that have a density less than water (less than 1g/mL) will float on water.

An interesting note is that the milliliter and the gram are actually defined by using the volume and density of water. A cube of water that is one centimeter on each edge is one cubic centimeter (cc) and equal to one milliliter (mL). This volume of water is defined to have a mass of one gram (g).

EXTENSIONS

Extension A: Mystery Solution
Students identify the density of an unknown solution of sugar water.

Extra Supplies
- large bowl or plastic gallon jug—1 per class
- extra pop-top squeeze bottle—1 per group
- extra plastic cup—1 per group

Extra Instructions
- To make the mystery sugar water mixture, fill the large bowl or plastic gallon jugs with 1 cup of water per student group. Add 1 to 4 spoonfuls of sugar (you choose) for each cup of water. Mix well. Fill the extra pop-top water bottles with the mystery solution.
- Give student groups a bottle of the mystery solution and an extra plastic cup.
- Ask students to use their straws and the other solutions to determine the density of the mystery solution. Students should pair this solution with their known solutions to see when their mystery solution floats and when it sinks.

Explanation
By comparing solutions in straws, students should be able to determine that the mystery solution is more dense than some solutions and less dense than others. It may not be possible to determine the exact density of the mystery solution, but students should be able to find a range of density for the mystery solution.

Extension B: Calculating Density
Students will measure the mass and volumes of the colored liquids in order to calculate the exact density of each. To do so, they will measure out certain volumes of the liquids and then weigh them. The ratio of the mass to the volume of the liquid is the density.

Extra Supplies

- scale or balance—1 per group
- graduated cylinder or other measuring container—1 per group or class
- extra plastic cups or other weighing containers—1 per group

Extra Instructions

- Use the Scientific Procedure sheet and Data Sheet for this extension.
- Students must carefully measure both volume and mass.
- After students have determined the density of each solution, they should verify that it matches with their observations in the general procedure.
- If they have also completed Extension A, they should verify that their measurements confirm their observations of the mystery solution.

Explanation

The density of any substance can be determined using the formula:

$$\textbf{density} = \frac{\textbf{mass}}{\textbf{volume}}$$

Denser solutions have a larger mass squeezed into a smaller volume. When mass is divided by the volume, the value for density is larger. The solutions that are less dense have a smaller mass in a larger volume. In this case, the value for density will be smaller.

Extension C: Stack of Liquids

Using the methods from Extension B, the density of any liquid can be determined. Give students the following challenge: Find three household liquids that can be stacked in a cup according to their density.

Extra Supplies

- one or more of a variety of liquids: oil, vinegar, honey, ketchup, glue, dish soap, rubbing alcohol, corn syrup, molasses, water, salt water, sugar water—½ cup per group, or less, depending on setup
- plastic cups—3 per liquid, or more, depending on setup
- scales or balances—1 per group
- graduated cylinders or other measuring devices—1 per group

Extra Instructions

- Use the Scientific Procedure sheet and Data Sheet for this extension to have students measure the volume and then measure the mass of each liquid.
- After finding the density of the liquids, students should sort the liquids in order from most dense to least dense.
- Have the students test their predictions/calculations by carefully pouring some of each liquid into a cup so that all the liquids stack.

- **Hint:** If students tilt the cup and run the liquid down the side, it is easier to create the layers.
- **Hint:** Rather than have all students share stock bottles, halfway fill plastic cups with each of the variety of liquids. Each plastic cup should have ¼ to ½ cup of liquid. This allows for more students to have access to any liquid.

CROSS-CURRICULAR CONNECTIONS

SOCIAL STUDIES

Population Density

Use the census data links provided to get population information. From this data, calculate the population density of cities, towns and states.

PHYSICS

Buoyancy

Have students design boats from clay or aluminum foil. (Both objects are denser than water and normally sink.) By increasing the volume of the clay or foil they can create a vessel that will float or hold cargo. Things that float have positive buoyancy; things that sink have negative buoyancy

Flinkers

Supply students with an array of items and challenge them to make an object that has an equal density to water. This object doesn't float, doesn't sink, so it "flinks." Flinkers are things that have neutral buoyancy. Students can attach two objects together, one that sinks and one that floats, and see if they negate each other. Stick paper clips into a cork, attach a balloon to a washer, or glue Styrofoam to a rock.

OCEANOGRAPHY METEOROLOGY

Ocean Currents

Temperature differences also cause differences in density. When water is cold, the water molecules are more tightly packed, so it sinks. Since warmer water is less dense, it will rise. It is this property that creates the ocean currents and determines weather patterns all over the globe.

Lava Lamp

A good demonstration of how density changes with temperature can be seen in a lava lamp. These lamps have two liquids: oil and wax. The wax floats and sinks in the oil as it changes density. When the wax is at the bottom of the lamp near the bulb, it heats up and rises. When it reaches the top of the lamp, it cools down and sinks.

RESOURCES

Web—http://antwrp.gsfc.nasa.gov/apod/ap001127.html
This satellite picture of the Earth at night shows how people are distributed around the world. The lit areas are densely populated cities.

Web—http://www.census.gov/population/www/censusdata/density.html
Many links to population data of cities and states. Some have calculated density, some have data for calculation.

Web—http://www.hometrainingtools.com/articles/exploring-liquid-density-newsletter.html
More activities for studying the density of liquids.

Web—http://www.exploratorium.edu/climate/primer/hydro-p.html
Good article explaining ocean currents and their role in climate change. Shows pictures of ocean currents and describes how salt concentration and temperature play a role.

Great Explorations in Math and Science (GEMS), *Discovering Density*, Lawrence Hall of Science
Target level: 6th to 10th grade
This teachers' manual includes five 25- to 50-minute lessons and possible follow-up lessons. Each activity is well designed and includes detailed instructions, handouts, and data tables.

VOCABULARY

atom: a very, very small particle that makes up all matter

demographer: a scientist who studies the characteristics of human populations, such as size, growth, density, distribution, and vital statistics

density: describes how tightly packed matter (molecules, people) is in a space; dense is the adjective, density is the noun

dissolve: when the molecules of one substance separate and become completely surrounded by the molecules of another substance

dots per inch (dpi): a measure of digital picture resolution; the number of dots that fit in a line one inch long

mass: the amount of matter in an object or substance; measured by weight

matter: anything that has mass and occupies space; stuff

molecule: a group of at least two atoms held together in a definite arrangement

population scientist: a scientist who studies the growth and density of populations

volume: the amount of space filled by an object or substance

Density Rainbow

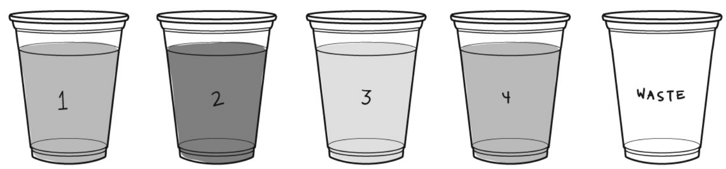
SCIENTIFIC PROCEDURE

1. Label four cups from #1 to #4.
Label the fifth cup "waste."

2. Half fill cups #1 to #4 with water.
Add sugar to each cup according to the chart.

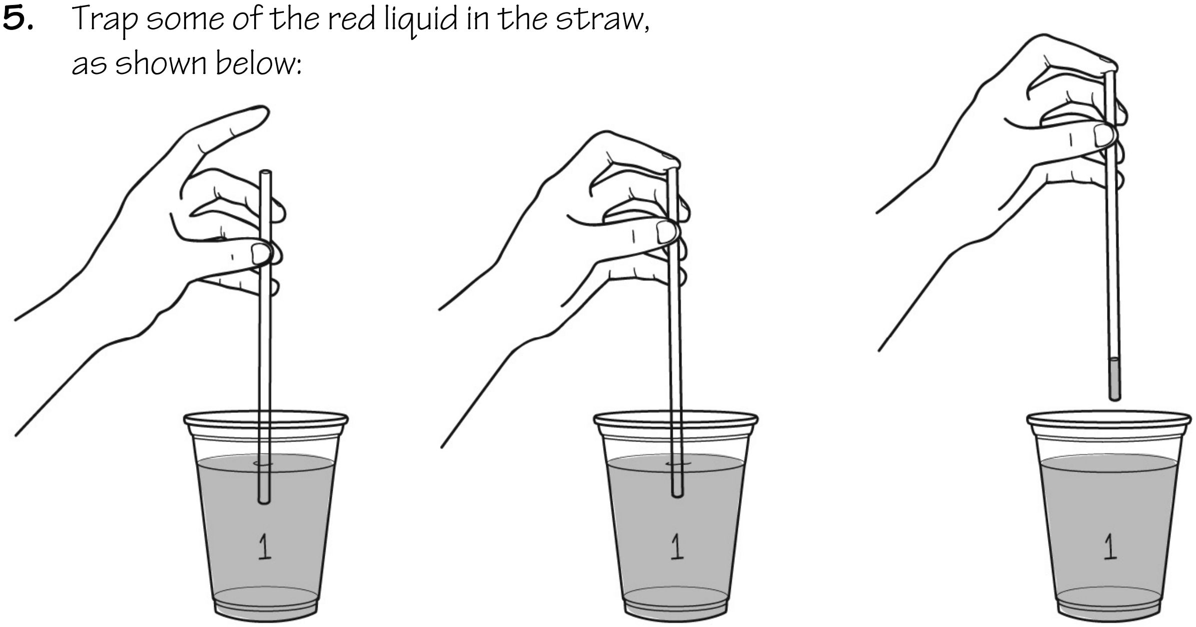
Cup	Sugar (spoonfuls)	Color (4 drops)
1	1	red
2	2	blue
3	3	yellow
4	4	green

3. Add water to cups #1 to #4 to look like the picture.
Color the water in each cup according to the chart.



4. Stir the water until all of the sugar has dissolved.

5. Trap some of the red liquid in the straw, as shown below:

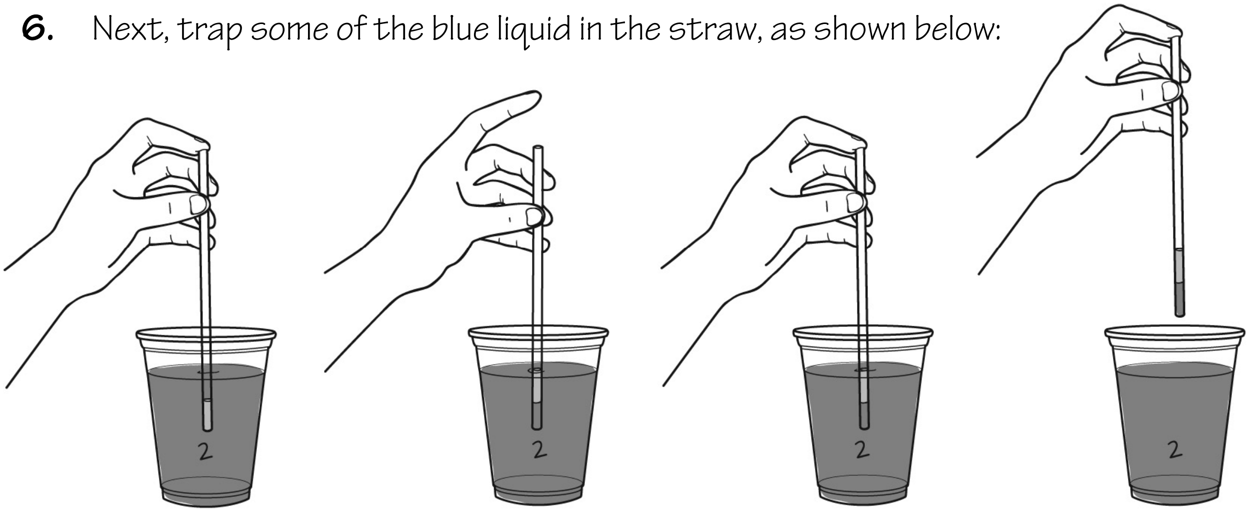


Dip the straw in about ½ inch.

Put your finger over the top of the straw …

… and lift the straw out of the cup. Keep your finger on the straw!

6. Next, trap some of the blue liquid in the straw, as shown below:



Keep your finger on the straw and lower it into the next cup.

Take your finger off the top of the straw to let the other solution in.

Put your finger back on the straw …

… and lift the straw out of the cup.

- What happened? Did the colors mix or stay separate?

7. Continue this procedure with the rest of the cups of colored water. **Remember that you must put the straw lower in the water than the level of liquids in the straw, or else no more water will enter the straw.**
    - What happened? Did the colors mix or stay separate?

8. Empty your straw into the waste cup.

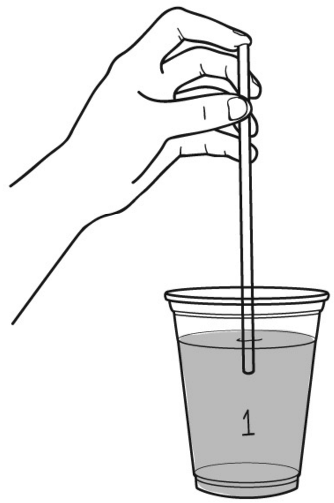
9. Try adding the colors in a different order. Experiment with many different orders.
    - What order makes the colors mix the most?
    - What order makes each color stay separate?

10. Clean up your area.
    - Follow your teacher's directions.

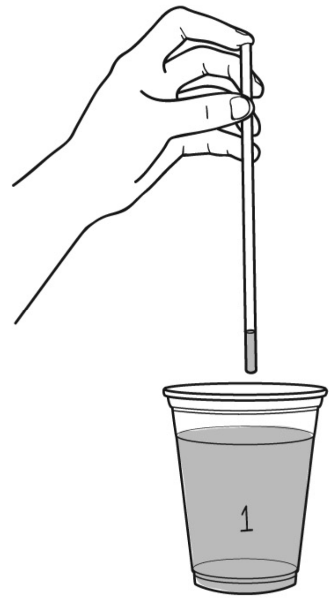
Making a Density Rainbow

Close up of straw procedure

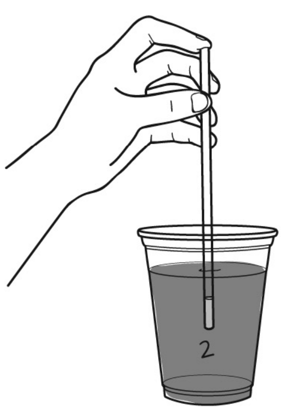
Dip the straw in about ½ inch.



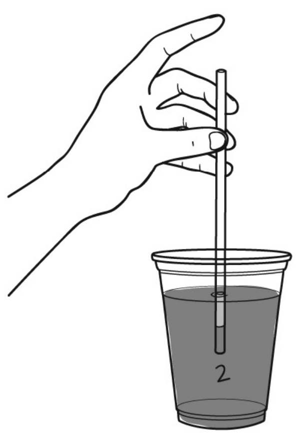
Put your finger over the top of the straw …



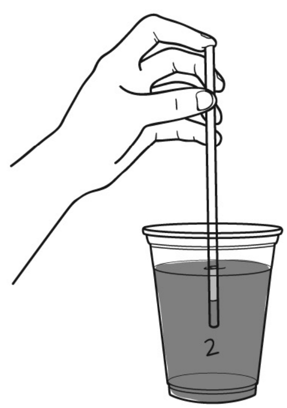
… and lift the straw out of the cup.



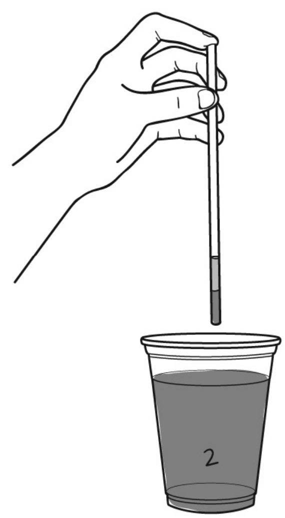
Keep your finger on the straw and lower it into the next cup.



Take your finger off the top of the straw to let the other solution in.



Put your finger back on the straw …



… and lift the straw out of the cup.

Density Rainbow

SCIENTIFIC PROCEDURE
for EXTENSION B or C

1. Choose a liquid. Write the name of the liquid in column A on the Data Sheet.

2. Measure the mass of an empty container using a scale or balance. Record the mass in column B on the Data Sheet. Remember to write the correct units with your measure.

3. Carefully measure at least a tablespoon (15 ml) of the liquid. Record the volume of your liquid in column E on the Data Sheet.

   Remember to write your units with your measure.

4. Add the liquid to the container you just weighed.

5. Record the mass of both the liquid and the container in column C on the data sheet.

6. Find the mass of the liquid. To do this, subtract the value in column B from the value in column C on the Data Sheet. That is:

   mass of container and liquid - mass of container = mass of liquid

   Remember to write units with your value in Column D.

7. Calculate the density of the liquid. To do this, divide the mass of the liquid (column D) by the volume of the liquid (column E). That is:

$$\text{density} = \frac{\text{mass of liquid}}{\text{volume of liquid}}$$

   Remember to write units with your value in Column F.

8. Repeat steps 1 through 6 for all your liquids, recording the values on the Data Sheet.

9. Clean up your area.
   - Follow your teacher's directions.

Density Rainbow

DATA SHEET
for EXTENSIONS B or C

A	B	C	D	E	F
name of liquid	mass of container	mass of container and liquid	mass of liquid	volume of liquid	density

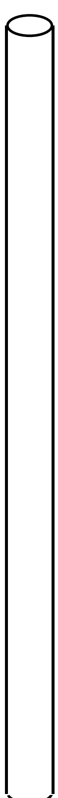
Density Rainbow

DATA SHEET

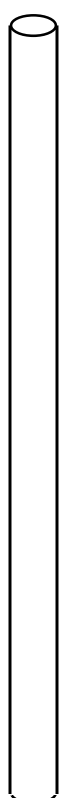
Color a picture of your straw each time you fill it with liquids.
Beside each picture, list the order you added the colors to the straw.

- Did they stay in the order you added them?

- Did they mix together?



Notes:



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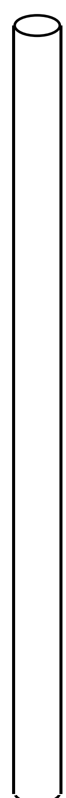

Notes:

This worksheet is available online at **www.omsi.edu/k8chemistry.**

Density Rainbow

Recommended group size: 2–4

Number of Students: ☐ Number of Groups: ☐

Supplies	Amount Needed	Supplies on Hand	Supplies Needed
tall, clear, narrow plastic cups (9 oz. or 12 oz.)	6 per group		
masking tape	1 roll per group		
permanent markers (e.g., Sharpie™)	1 per group		
granulated sugar	1 cup per group		
teaspoon measure	1 per group		
clear plastic drinking straws	1 per student		
pop-top squeeze bottles (e.g., water or sports drink)	2 per group		
food coloring (red, green, blue, and yellow) OR sugarless Kool Aid™ packets of same colors	set of 4 colors per group		
access to a sink	a total of 3–4 gallons of water is needed		
towels and sponges	several for class		
Extension A			
large bowl, pitcher, or plastic gallon jug	1 per class		
extra pop-top squeeze bottle	1 per group		
extra plastic cup	1 per group		
Extension B			
scales or balances	1 per group		
graduated cylinder or other measuring container	1 per group		
extra plastic cups or other weighing containers	5 to 7 per group		

Supply Worksheet continues on next page.

Extension C			
variety of liquids: oil, vinegar, honey, ketchup, glue, dish soap, rubbing alcohol, corn syrup, molasses, water, salt water, sugar water	1–2 cups of each liquid per class		
plastic cups (optional)	2 or 3 per liquid		
scale or balance	1 per group		
graduated cylinder or other measuring container	1 per group		
extra plastic cups or other weighing containers	5 to 7 per group		
Teacher Demonstration			
Sink or Float			
large jar, glass, plastic cup, or aquarium filled with water	1 per class		
assortment of small objects to test: paper clip, Styrofoam, penny, cork, nail, rock, wood, golf ball, ping pong ball, pencil, eraser, marble, etc.	1–2 of each item		
assortment of liquids to test: oil, honey, corn syrup, alcohol, ketchup	¼ cup of each liquid		