

## Exploring Density!

| FRAMEWORK                                                                                                                                                                                                                   |
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| I. Scientific and Engineering Practices <ul style="list-style-type: none"><li>• 1. Asking questions</li><li>• 4. Analyzing and interpreting data</li><li>• 8. Obtaining, evaluating and communicating information</li></ul> |
| II. Cross-Cutting Concepts <ul style="list-style-type: none"><li>• 1. Cause and effect: Mechanism and explanation</li></ul>                                                                                                 |
| III. Physical Sciences <ul style="list-style-type: none"><li>• PS 1: Matter and its interactions</li></ul>                                                                                                                  |

| SKILLS/OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| <ul style="list-style-type: none"><li>o Learning about density and how it relates to water</li><li>o Understanding how density depends on the temperature of a liquid</li><li>o Exploring the density of different liquids</li><li>o Learning how to compare the different densities of liquids based on visual observations and drawing scientific conclusions from these observations</li><li>o Applying the concept density to how things can float</li><li>o Making predictions about the buoyancy of objects</li></ul> |

| MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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| <ul style="list-style-type: none"><li>o Ipod and speakers (some way to play music)</li><li>o Water – can probably get at the school, but need containers to carry it in</li><li>o 8 Empty clear plastic water bottles</li><li>o Corn Syrup (2 bottles)</li><li>o Rubbing Alcohol (2 bottles)</li><li>o Vegetable Oil (1 bottle)</li><li>o 3 glass beakers (300mL)</li><li>o 20 plastic spoons</li><li>o 20 plastic cups</li><li>o 5 tin foil trays</li><li>o 5 of the following items:<ul style="list-style-type: none"><li>o feathers</li><li>o rocks</li><li>o pennies</li><li>o tissues</li><li>o craft sticks</li><li>o corks</li><li>o pens</li></ul></li></ul> |

- o ping pong balls
- o toothbrushes
- o foam balls

## BACKGROUND

- A recap of the water theme from the previous week
- Water is a liquid with a specific “density”  
Has anyone heard the words “density” or “dense” before?
- Density is the amount of “stuff” in something
  - o Things that are more dense are more closely packed together
  - o Things that are less dense are not closely packed together.
  - o For example, think of cows in a fenced off field. The field is a certain size and stays that same size. If we add a lot of cows to the field, we are adding more and more stuff and this makes the field more dense. But if we take some cows out of the field, the field can be considered less dense because there is less stuff in the same area.
- We are going to discuss the density of liquids
- Density relates to floating because things that are less dense can float on top of things that are more dense
- We can use this property of water to compare it to other liquids and draw conclusions about it

- o Rulers
- o Modeling Clay

## NOTES

- Density can be a tough concept to explain to kids. It may be simpler to refer to it as the amount of “stuff” in something instead of using the word “molecules.” The Density dance game should help to illustrate this general definition.
- Activity 4 is only for the older kids, and it may still be too confusing for them
- This lesson may be too long, if so, Activity 1 and 3 are the most important

Activity #1  
(Game)

**Density Dance**

|           |                                         |
|-----------|-----------------------------------------|
| Materials | A way to play music (iPod and speakers) |
| Worksheet | No                                      |

This activity will serve as an introduction to density so that the kids gain a familiarity with the meaning of the terms. It may be necessary to split the younger and older children into separate groups so that things don't get too wild.

1. Begin by having all of the students stand up in a circle. Explain that the word "density" can be used to describe the group because there are a certain amount of "things"(in this case people) in a specific area (the room).
2. Then have all of the students move in very close together. Explain that they formed a "dense" group because they still have the same number of people but in a much smaller area.
3. Then have the students spread out throughout the room. This represents something that is "not dense" because the same number of things (people) is spread out in a much larger area.
4. Once the students understand the meaning of "very dense" and "not dense," have them play the density dance game. This game is similar to musical chairs in that music will be playing and the students will be dancing around, but when the music stops, a science club member will call out "very dense" or "not dense" and the kids will have to move as a group to illustrate this word. Either the students will have to spread out for "not dense" or move close together for "very dense."
5. Play the music and stop it three or four times, changing what is called out. "Medium density" could be called out to see if the kids catch on. The game could also be extended to include actual liquids (i.e. Salt water and fresh water, and hot water vs. cold water) especially for the older kids.
  - a. Salt water has salt molecules in it, so there is more stuff in the same area. Therefore it is denser. Fresh water does not have these extra molecules of salt so it is less dense. Try calling out "salt water" or "fresh water" so see if the kids catch on.
  - b. Hot water vs. Cold water
    - i. Explain that the hot water has molecules with more energy. These molecules want to move around a lot because they have energy. Describe how the kids would probably run into each other if they were in a small space and were moving quickly. It would be easier if the kids spread out and become less dense. Have the kids spread out far away from each other and move around quickly to represent hot water.
    - i. In cold water, the molecules don't have a lot of energy and therefore they can be very close to each other. Have all of the kids move in very close to each other and stand very still to represent cold water

- ii. Therefore the cold water is much more dense than the hot water.

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| Activity #2<br>(Activity) | <b>Density Rainbow</b>                                                                                                                                                                                                                     |
| Materials                 | <ul style="list-style-type: none"><li>- Empty plastic water bottles</li><li>- Corn syrup</li><li>- Rubbing Alcohol</li><li>- Water</li><li>- Vegetable Oil</li><li>- Food Coloring</li><li>- Paper Cups</li><li>- Plastic Spoons</li></ul> |
| Notes:                    | Work in groups of three<br><ul style="list-style-type: none"><li>- have an instructor at each table so help discuss the activity as it progresses</li></ul>                                                                                |

This activity demonstrates the different densities of liquids and proves that less dense liquids can float on liquids that are denser.

1. Divide into groups of about 3 students and one Science Club instructor. Each group should have an empty water bottle.
2. **Fill the bottle about  $\frac{1}{4}$  full of water. The students should pick a color food dye and add 2 drops to the water. Mix the food coloring into the water.**
3. Inform the students that corn syrup will be added and ask them what they think will happen.  
Will the corn syrup mix with the water? Will it stay on top of the water?
4. Give the kids a cup of corn syrup and have them dye it a color of their choice. **Add 2 drops of a different color to the cup of corn syrup. Use a plastic to mix the food coloring with the syrup. Pour the corn syrup into the water bottle until the bottle is  $\frac{1}{2}$  full.** Observe what happens.
  - a. What does this tell us about the density of corn syrup?
  - b. The corn syrup is more dense than water so it can't float on top. Instead it sinks to the bottom of the bottle.
5. **Now add the vegetable oil until the bottle is about  $\frac{3}{4}$  full of liquid.** The vegetable will not be dyed.
  - a. What happened when the oil was added? The oil bubbled because it doesn't like water. It is actually afraid of water (hydrophobic) and would rather stay in its own bubbles than mix with the water.
  - b. The vegetable oil is also less dense than the water so it floats on top of it.

6. Before adding the rubbing alcohol ask the students what they think will happen: will the rubbing alcohol go to the bottom? Will it go in between the water and oil? **Pour rubbing alcohol into the bottle until it is nearly full. Observe the layers that formed.** The rubbing alcohol will not be dyed.
  - a. What do the layers tell us about the densities of each of the liquids? Where are the less dense liquids found?
  - b. Recap that this means that the less dense liquids can float on top of the liquids that are denser. Relate this to floating in general: For things to float, they must be less dense than the medium in which they are floating.

FOR OLDER ONLY:

| Activity #3<br>(Activity) | Making a Hydrometer                                                                                                                                                                                                                           |
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| Materials                 | <ul style="list-style-type: none"> <li>- three plastic containers per group (labeled)</li> <li>- Salt</li> <li>- Rubbing alcohol</li> <li>- Water</li> <li>- Clay</li> <li>- Straws</li> <li>- Permanent markers</li> <li>- Rulers</li> </ul> |
| Worksheet                 | Yes there is a worksheet<br>Work in groups of three<br>- have an instructor at each table                                                                                                                                                     |

This activity involves exploring how things float depending on their density. Recap that for things to float they must be less dense than the medium/liquid in which they are floating.

1. Take the three plastic containers and fill one with water, one with salt water (add a sufficient amount of salt to the warm water), and another with rubbing alcohol.
2. Help the students make a hydrometer (there is an sample one made in the box). **Take a straw and close one end off with a chunk of clay. Then use the permanent marker to draw lines on the straw 2 centimeters away from each other (as measured using the ruler). Number the lines from the top (the end without the clay) starting with 1.**
3. Explain that for the hydrometer to float it has to be less dense than the liquid in which it is floating. Therefore it has to be less dense than water, salt water, and rubbing alcohol.
4. **Place the hydrometer in the fresh water with the clay end down. Look at the line on the straw that lines up with the level of the water. Record this number on the worksheet.**

5. **Remove the hydrometer and place it in the beaker of salt water. Look at the line on the straw that is even with the water level and record this number on the worksheet.**
6. **Repeat step number 6 for the rubbing alcohol.**
7. Have the kids look at the values they got for each of the liquids. The number should be lowest for rubbing alcohol and highest for the salt water. The water should fall in the middle.
  - a. Rubbing alcohol is the least dense, and therefore it is harder to the straw to be less dense than it. This means that the straw does not float as well in the rubbing alcohol. This is exhibited as a low line number on the hydrometer.
  - b. The salt water is the densest and therefore it is easiest for the straw to be less dense than the salt water. The straw floats highest in the salt water and therefore has a higher number on the hydrometer.

FOR YOUNGER KIDS:

| Activity #3<br>(Activity) | Sink or Float?                                                                                                                                                                                                                                                                                                  |
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| Materials                 | - 5 plastic bins<br>- Water<br>5 of the following items:<br>- feathers<br>- pennies<br>- rocks<br>- corks<br>- tissues<br>- pencils<br>- ping pong balls<br>- leaves<br>- pieces of yarn<br>- rubber bands<br>- tin foil<br>- piece of paper<br>- paper clips<br>- matches<br>- sticks<br>- plastic bottle caps |
| Worksheet                 | - There is a worksheet for this activity<br>Work in groups of 3<br>- have an instructor at each table                                                                                                                                                                                                           |

This activity is designed to help kids explore which objects float and which objects sink in water.

1. Fill the plastic bin with some water (about 2/3s full).
2. Give each group a bag of items. Have the kids work in groups and predict whether they think each of the objects will float or sink. **Examine the different objects and predict whether they will float or sink. Record the predictions.**
3. **Test each of the objects one at a time by placing it on the surface of the water. Record whether the object sinks or floats.**
4. **Group the objects that float together in piles. Those that float and those that sink.**
  - a. Encourage the kids to draw conclusions about the objects that float and those that sink. What can we conclude about their densities? Which objects have a density less than water? Which objects have densities greater than water?

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#### CONCLUSIONS

- Density is the amount of stuff in a certain area
- Density depends on the temperature: hot water is less dense than cold water
- Density also depends on the type of liquid. Liquids that are less dense can float on top of liquids that are denser
- Similarly, objects that are less dense than water can float on top of it. But objects that are denser than water sink.
- Density isn't just used to describe liquids, and can apply to many different things. Ask the kids: Which do you think is more dense, a rock or a feather? Which has more "stuff in it"? If you had a pound of rocks and a pound of feathers, which would be more dense?

NOTE: If there is time, you could play the density game again but this time call out the different liquids that were used in the density rainbow.