Lesson 4: Using Density to Predict Estuarine Salinities

Focus Question:
How can you use density principles to determine different salinities?

Objectives:

- To apply principles of density to demonstrate why one liquid floats on top of another.
- To determine the logical order of varying salinities in an estuarine system.

S.C. Curriculum Standards:
7-5: The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes.

Purpose: This is a lab-based activity in which students apply their understanding of density to determine differences in four unknown salt solutions, using critical thinking skills, testing and observations. The solutions represent different salinities found within coastal and estuarine environments.

Time Duration: 2 hours

Vocabulary:
Density- the amount of matter in a known volume of an object or substance
Salinity- the amount of salt dissolved in water
Solution-a mixture with one substance evenly distributed in another substance so that they are difficult to tell the two apart

Materials:
Each Group of Students:

- 4 plastic droppers
- 4 plastic cups
- 5 plastic or glass test tubes
- Waste container (plastic liter bottle)
- Student Worksheet (Appendix 1)

Procedures:
Preparations prior to class: (can be done the day prior to lesson)
Make four 2-liter bottles of fresh to salt solutions, each with a different color.

- Blue: 12 drops of food coloring, no salt, water to fill container, label with the letter B
- Yellow: 12 drops of food coloring and ¼ cup of salt and water to fill container, label with a letter D
- Red: 12 drops of food coloring and ½ cup of salt and water to fill container, label with the letter A
- Green: 12 drops of food coloring and 1 cup of salt and water to fill container, label with the letter C.

Hooking Students

1. Read the following scenario: A graduate student in oceanography took four water samples at her study sites located along a river that flows into the ocean (sites are the white stars in Figure 1). One sample is saltwater from the ocean, one sample is fresh water from the river, and the other two samples were collected in the estuary between the freshwater and ocean sites. Being in a hurry, she forgot to label the samples throughout that sampling day! Now, your job is to fix this problem for this student by identifying the site of each sample. (NOTE: No tasting of solutions is allowed since the student as the water quality or bacteria levels of the water are unknown.)
2. You are to determine the correct order of the four solutions from freshwater river to the ocean by utilizing knowledge of density principles.
3. Your task is to discuss what you expect the differences to be at the four sites. Consider color, temperature, salinity and other factors. Lead students to consider salinity based on density principles.

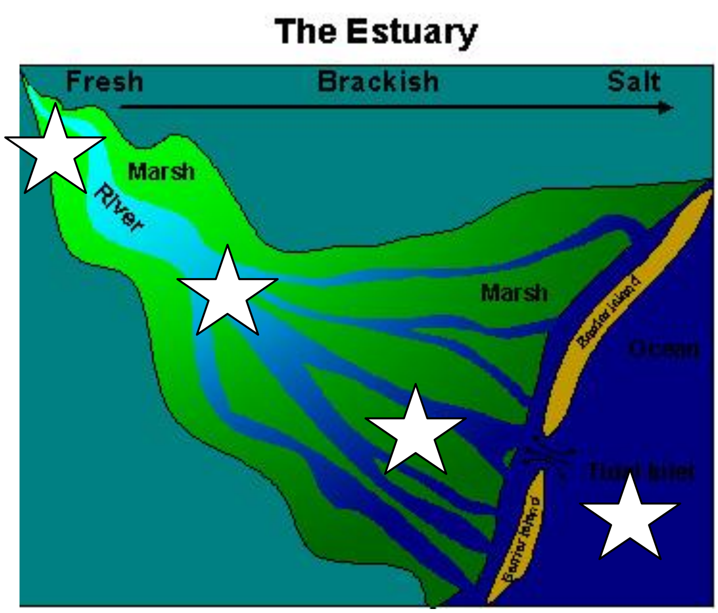


Figure 1. Sample stations (stars)

Student Engagement

You are to determine the differences in the four samples by comparing two samples at time to see which is denser (which fluid will "float" on the other?)

Methods: With a small cup of each solution per group, perform the following procedures:

1. Using the dropper, dribble 6-10 drops of one color solution into a dry test tube.
2. Take another color solution and dribble the same amount into the same test tube, letting the liquid slide down the side slowly, so that you do not disturb the solution already in the tube.
3. Observe and record which solution floats or sinks. Record the results in Table 1.
4. Now prepare another tube using one of the first solutions and then add a new colored solution.

5. Observe and record which solution floats or sinks.
6. Repeat this procedure, testing each color with another and record the results.

Results:

Table 1. "Floating and Sinking" Density Data comparing two samples at a time

Test Trial Tube 1			
Most dense (sinks) Color:		*Least Dense (floats) Color:*	
Test Trial Tube 2			
Most dense (sinks) Color:		*Least Dense (floats) Color:*	
Test Trial Tube 3			
Most dense (sinks) Color:		*Least Dense (floats) Color:*	
Test Trial Tube 4			
Most dense (sinks) Color:		*Least Dense (floats) Color:*	
Test Trial Tube 5			
Most dense (sinks) Color:		*Least Dense (floats) Color:*	

Conclusion:

1. Using the Data Table, determine the densest solution, least dense, and the order of the two between and record order below. This require you to think carefully about each of the trials you did.

Most Dense	Less Dense	Next to Less Dense	Least Dense
Color:	Color:	Color:	Color:

2. Apply your critical thinking results to a real application. Take one clean test tube and try to layer the four colors in the order of your results. Which color should be dribbled in first, most dense or least dense?
3. Is your conclusion about the density differences in the solutions in the Chart supported by your results of the layering of the 4 solutions?
4. If each of your solutions represents a different salinity, then place your prediction of where each sample was taken on estuary graphic

Student Reflection:

How can you use principles of density to determine different salinities?

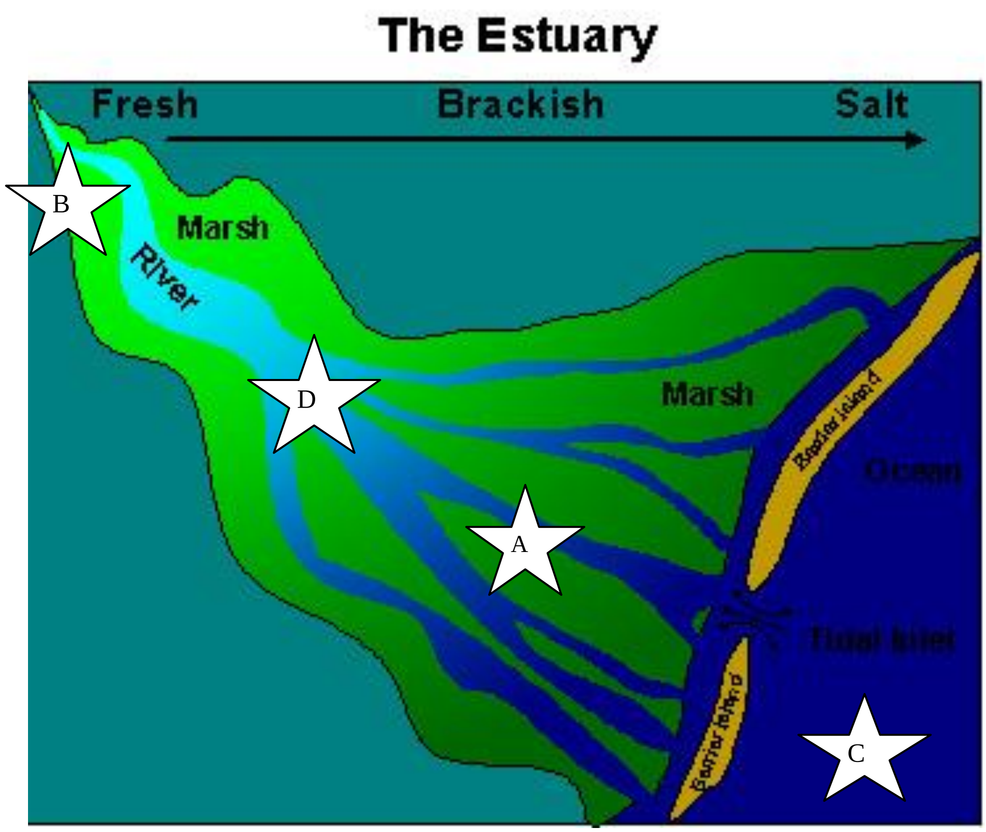
Appendix 2: Student Worksheet (Teacher Copy):

1. What happened when you slowly layered one solution with one other solution?
   The more dense solution or more salty sank. It I put in the least dense first, I got a mixture.

2. What evidence do you have about each samples was collected?
   The freshwater river sample was the least dense. The ocean sample was the most dense.

3. Label the stars with the appropriate letter from the samples. Fill in the squares with the color of solution that corresponds to the stars below?

A: *Red*	B: *Blue*	C: *Green*	D: *Yellow*



4. What do you think the graduate student should do to prevent this problem again?
   Label the samples immediately when you take them.

5. What environment would have water with the greatest density: river or ocean? Why?
   The ocean has the greatest amounts of dissolved salts and the greater density

Focus Question: How can you use density principles to determine different salinities?

Student Worksheet:

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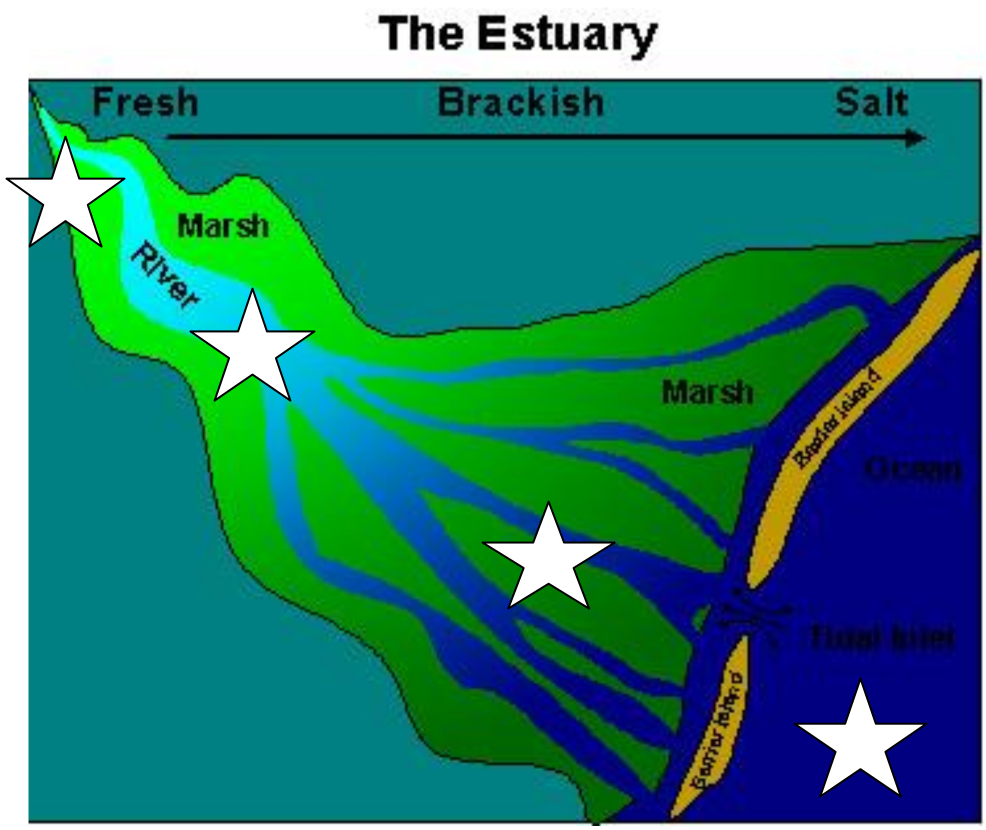

4. What do you think the graduate student should do to prevent this problem again?

5. What environment would have water with the greatest density: river or ocean? Why?

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Appendix 3: Background Information:

Taken with permission from "*Of Sand and Sea*" by P.Keener-Chavis and L. Sautter.

Density

Variations in density of the ocean are a function of salinity and temperature. Density or the ratio of mass to volume is the mass of salts dissolved in a volume of water. Oceanic waters with higher salinities are denser than oceanic waters with lower salinities. In other words, a liter of water with a salinity of 36‰ (parts per thousand) weighs more than a liter of water with a salinity of 32‰ (parts per thousand)=more dissolved salts. Additionally, waters that have cooler temperatures have higher densities than waters with warmer temperatures (molecules of water are packed more tightly). Ocean waters with higher salinities and cooler temperatures have the greatest densities. Dense water masses actually "sink" toward the ocean floor and start great oceanic density currents moving near the ocean floor. River waters, less dense ocean water masses "float" at or near the ocean's surface. The Amazon River waters can be detected at the surface nearly 200 miles from the mouth.