

Lesson 2: Density, Salinity, and Water Behavior (2 Days)

☐ Getting Started

In the last lesson, you zoomed in....way in...to explore a single water molecule. You discovered that even something as small as H_2O has powerful properties that help explain why water behaves the way it does. Now, it's time to zoom back out.

Think about the ocean. Have you ever wondered why some things float while others sink? Or why does ocean water form layers instead of mixing all at once? These patterns aren't random; they are controlled by two important ideas: **density** and **salinity**.



In this lesson, you'll investigate how adding salt to water changes its behavior. You'll measure, observe, and test different solutions to see how water moves, settles, and interacts with itself. By the end of this lesson, you won't just understand water; you'll start to think like a scientist, using evidence to explain what's happening beneath the surface.

Stuff You Need

- *Water: The Story of the Hydrosphere, Second Edition* by Lynne Z. Petkovic, M.Ed., J.D.
- blue food coloring (kit)
- colored pencils
- eye dropper (kit)
- graduated cylinder (kit)
- green food coloring (kit)
- ice cube tray (kit)
- large clear cups (kit)
- measuring cup
- measuring cups and spoons
- pot
- red food coloring (kit)
- salt (10-15 Tbs)
- scale (kit)
- small clear cups (kit)
- yellow food coloring (kit)

Ideas to Think About

- How do the properties and structure of water impact Earth's systems and support life on Earth?

Things to Know

- The **density** of a material is its mass per unit volume. Density is mass divided by volume ($D = \frac{M}{V}$).

- Substances have different densities depending on their content. For example, tap water is less dense than salt water.
- Mass and weight are not the same - mass measures the amount of matter in an object, and weight measures how heavy the object is.
- **Salinity** is a measure of how much salt is in water. Salinity and temperature influence density.
- Differences in salinity and density affect how water moves and mixes.

☐ Reading and Questions

Read Chapter 2 in the book *Water: The Story of the Hydrosphere*. Then, answer the questions.

1. What are the two main factors that affect the density of water?

2. Why does cold water usually sink below warm water in lakes and oceans?

3. How can small differences in temperature and salinity lead to large-scale movement of water around Earth?

Activities

☐ Activity 1: Making Density Solutions - Part 1

In the reading for today, you learned about density—an important characteristic of water. **Density** describes how much matter is packed into a certain amount of space. To understand density, you need to understand two important ideas: mass and volume. Mass measures how much matter is in an object, while volume is the amount of space an object takes up. It's important to note that mass is different from

weight—mass measures how much matter something has, while weight describes how heavy it feels.

Density is calculated by dividing mass by volume.

Another important characteristic is **salinity**, which is a measure of how much salt is dissolved in water. Understanding these concepts will help you explain how water behaves and how it interacts with living and nonliving things on Earth. In Lesson 1, you explored how water is made of tiny molecules. Today, you will build on that idea by observing what happens when another substance—salt—is added to water. In this lesson, you will conduct an investigation into the density of different solutions. A solution forms when one substance dissolves and spreads out evenly in another.

Scientists also pay attention to whether a change is a physical change or a chemical reaction. A physical change occurs when a substance changes form, size, or state, but no new substance is created. For example, ice melting into liquid water, water evaporating into water vapor, or salt dissolving in water are all physical changes. The substances are still the same; they are simply arranged differently.

A chemical reaction occurs when substances combine or change to form one or more new substances with different properties. For example, when iron rusts, a new substance called iron oxide forms. Baking a cake and burning wood are also examples of chemical reactions because new substances are produced.

But when substances mix, an important question arises: *does a chemical reaction occur, or is it simply a physical change?*

As you complete this activity, you will observe what happens when salt is added to water and use your observations to determine whether a new substance forms.

Density — Making Solutions

Before you begin, let's think like scientists. When substances are combined, sometimes a chemical reaction happens, and sometimes it does not. You may be asking yourself: *What is a chemical reaction?*

A chemical reaction occurs when substances change into *new substances* with different properties. Here are some clues that a chemical reaction may have happened:

- A gas forms (bubbles)
- A color change occurs
- Heat or light is produced
- A new solid forms (precipitate)

As you complete this activity, you will observe carefully and decide: *Did a chemical reaction occur when salt was mixed with water?*

Today, you will create a 100% saltwater solution and then use that solution to make 25% and 50% saltwater solutions. You will create ice cubes of each solution for use in tomorrow's investigations.

You will need approximately 2 cups of water and 10-15 Tbs. of salt. Follow these steps to create your 100% saltwater solution:

1. Put approximately 2 cups of water into a pot on the stove. Ask a parent for permission prior to using the stove. Turn the heat on to medium. You want the water hotter than hot tap water, but it should not be boiling; if the water begins to boil at any point, just turn the heat down.
2. Stir one tablespoon of salt into the water until it dissolves completely.
3. Continue adding salt, one tablespoon at a time, stirring after each addition. Eventually, the water will not be able to dissolve any more salt. When this happens, the solution is saturated. You may notice:

*Salt remains at the bottom of the pot even after stirring.

*The water may look slightly cloudy.

*The solution may become more difficult to stir.

Note: You will probably add around 10–15 tablespoons of salt before the solution becomes saturated, but the exact amount may vary.

4. Turn the heat off and let the water cool for about 10 minutes.
5. Carefully pour the liquid saltwater into a large clear cup or container, leaving any undissolved salt crystals behind in the pot. The salt crystals are no longer needed and may be discarded. The liquid you pour off is your saturated saltwater solution.
6. Label the container "100% Salt Water Solution." If possible, cover the container with plastic wrap, a lid, or aluminum foil to prevent spills or evaporation. Store it in a safe place. You will use this solution in Activities 2 and 3, so **do not throw it away until all three activities are complete.**

Now, on the activity page titled "Making Density Solutions," stop and think what happened to the salt.

☐ Activity 2: Making Density Solutions - Part 2

Once you have made your 100% saltwater solution, you will use it to make a small amount of a 25% and a 50% salt solution. Before you begin, take four clear cups and label them "Tap Water," "25%," "50%," and "100%." For this part of the activity, you

will be making two small ice cubes of each solution, so you won't need a large amount of each solution.

Salt Solutions for Ice Cubes		
Salt Percentage	Instructions (There are approximately 5 milliliters (mL) in one teaspoon (tsp) and 15 milliliters in one tablespoon (Tbsp).)	Food Coloring
0%	Pour approximately 40 milliliters of tap water into the "Tap Water" container	Add 2 drops of green food coloring and mix well.
25%	Mix 10 milliliters of 100% solution with 30 milliliters of tap water, and put this solution in the "25%" container.	Add 2 drops of red food coloring and mix well.
50%	Mix 20 milliliters of "100% Salt Water Solution" with 20 milliliters of tap water, and put this solution in the "50%" container.	Add 2 drops of yellow food coloring and mix well.
100%	Pour approximately 40 milliliters of "100% Salt Water Solution" into the "100%" container.	Add 2 drops of blue food coloring and mix well.

Density: Making Ice Cubes

You will now make ice cubes to use in one of tomorrow's experiments:

1. Pour enough of each solution into an ice cube tray to make two ice cubes from each solution (two green ice cubes, two blue ice cubes, etc.) for a total of eight ice cubes.
2. Put the ice cube tray in the freezer and leave it overnight. If some of the solutions do not freeze completely overnight, that is okay. Salt water found in the ocean freezes at 28 degrees Fahrenheit. As the concentration of saline increases, the freezing temperature will decrease. There is no need to give the saline solutions more time to freeze.
3. Special Note: You can pour out any remaining colored solutions, but **keep** your four labeled cups ("Tap Water," "25%," "50%," and "100%") and the 100% solution you made in Activity 1; you will use them to mix more solutions for Activity 3 tomorrow.

Day 2

☐ Activity 3: Water and Its Behavior

In Lesson 1, you learned that water is made of tiny, constantly moving particles. When you add salt to water, those salt particles don't disappear—they spread out and mix in between the water particles. Now, think about this:

- If you add more particles (salt) into the same amount of space, what do you think will happen to the mass?
- What might that mean for density?

You're about to find out.

First, locate the activity page titled "Water and Its Behavior." Complete the section titled "Step 1: Making a Prediction."

Now, you will create 100 milliliters of each of the four different solutions, similar to how you created them when you made the ice cubes. In this case, however, you will be creating exactly 100 milliliters of each solution.

First, set out your four clear plastic containers (the ones labeled "Tap Water," "25%," "50%," and "100%"). Before measuring the mass of each solution, use one of the empty clear cups to "zero" the scale. Place an empty cup on the scale. (Be sure to use a cup that is the same size as the ones that contain your solutions.) Then adjust the knob on the top of the scale until the dial reads exactly zero.

Then follow these instructions:

Salt Solutions for Measuring Mass and Density		
Salt Percentage	Instructions	Food Coloring
0%	Pour 100 milliliters of tap water into the "Tap Water" cup.	Add 2 drops of green food coloring and mix well.
25%	Mix 25 milliliters of 100% solution with 75 milliliters of tap water, and put this solution in the "25%" cup.	Add 2 drops of red food coloring and mix well.
50%	Mix 50 milliliters of 100% solution with 50 milliliters of tap water, and put this solution in the "50%" cup.	Add 2 drops of yellow food coloring and mix well.
100%	Pour 100 milliliters of "100% Salt Water Solution" into the "100%" cup.	Add 2 drops of blue food coloring and mix well.

Measuring Mass

Measure the mass of each of your solutions and record them in your data table. (Be sure you are reading the mass in grams and not ounces.)

Note that the volume of each solution should be 100 mL.

Now stop: Answer the question in the "Measuring Mass" section of the activity page.

Determining Density

In the table you created, you have recorded the mass and volume of the liquids measured. Now use those two measurements to calculate **density**. To determine the **density** of each solution, use the following formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Now finish the activity page. The ideas you explored in this activity don't just stay in the lab; they help explain how water behaves all over Earth. In the ocean, water is not all the same. Some parts have more salt, and some have less. These differences change the density of the water. As a result, some water sinks while other water rises. Over time, this creates layers in the ocean and helps drive the movement of water in large currents. In the next activity, you'll get to see this process in action.

☐ Activity 4: Density Variables

In this activity, you will explore different factors that can affect solution density.

You will conduct an investigation to determine the movement of water and how density influences this movement. During the experiment, you will use the table at the top of the "Movement Based on Density" page to record information.

For this activity, you will use the ice cubes you made yesterday. Follow these steps:

1. Fill four clear cups or glasses with 100 ml of room-temperature tap water.
2. If the solution froze into ice cubes, place an ice cube in each cup of tap water. Record your observations in the table on the "Movement Based on Density" page. (You made 2 cubes in case one did not freeze properly. Only use one cube per cup.)

Water Density



**DROPPER IN CUP
FOR THE BOTTOM**

3. If your solution did not freeze into ice cubes, use a medicine dropper to test the solution as a liquid instead.
- If the food coloring has settled, gently stir the solution first.
 - Fill the medicine dropper with the colored solution and wipe any liquid from the outside of the dropper.
 - Place the tip of the dropper near the bottom of the cup of tap water.
 - Slowly release the solution into the water.
 - Continue squeezing the dropper as you remove it from the cup so that you do not draw the solution back into the dropper.
 - Repeat two more times so that enough colored solution is visible.
 - Observe what happens. Look at the cup from the side at eye level rather than looking down from above.
 - Does the solution or ice cube float, sink, or stay in the middle? Describe what you observe and record your observations in the table on the "Movement Based on Density" page.

Once you have completed the activity, answer the "Things to Ponder" questions at the bottom of the activity page. Your answers may be as short as one sentence or as long as a brief paragraph.

Wrapping Up

In this lesson, you took a closer look at how water behaves when something is added to it. You discovered that even though all your solutions had the same volume, their masses, and therefore their densities, were different. By adding salt, you increased the amount of matter in the same space, which made the water more dense. You also saw how these density differences affect water's behavior. Denser water sinks, while less dense water floats. This helps explain why water can form layers rather than mix completely. Now think bigger.

If water in the ocean has different densities because of temperature and salinity, what might happen on a much larger scale? In the next lesson, you'll explore how these differences cause water to move around the planet, forming powerful ocean currents that help regulate Earth's climate.

Making Density Solutions

Directions: Use your observations from the investigation to answer the questions below.

Part A: Observations

1. Describe what you saw when the salt was added to the water. _____

2. What happened to the salt over time? **Hint:** *Did the salt really disappear, or is it still there in a different form? What would the water taste like now?*

☐ It disappeared

☐ It stayed the same

☐ It spread out in the water

☐ Other: _____



Part B: Looking for Evidence of a Chemical Reaction

3. Did you observe any of the following? (Check all that apply)

☐ Bubbles (gas formed)

☐ A new solid formed

☐ Color change

☐ None of these

☐ Heat or light produced

4. Based on your observations, do you think a chemical or physical reaction occurred?

☐ chemical reaction

☐ physical reaction

Explain your reasoning: _____

Part C: Thinking Like a Scientist

5. If the salt seems to "disappear," where did it actually go? _____

6. How does this connect to what you learned in Lesson 1 about water particles? _____

WATER AND ITS BEHAVIOR

You will be working with four solutions:

- Tap Water (0%)
- 25% Salt Solution
- 50% Salt Solution
- 100% Salt Solution

Each one will have the same volume: 100 mL. But they will NOT have the same amount of salt.



Make a Prediction

Think Before You Measure

Which solution do you think will have the greatest mass? Write your prediction and explain why:

Solution Name	Solution Mass (grams)	Solution Volume (mL)	Solution Density (grams/mL)
Tap Water		100	
25%		100	
50%		100	
100%		100	

Measuring Mass Question

Compare the masses of the four solutions. What pattern do you notice as salinity increases? Use evidence from your measurements to explain your answer.

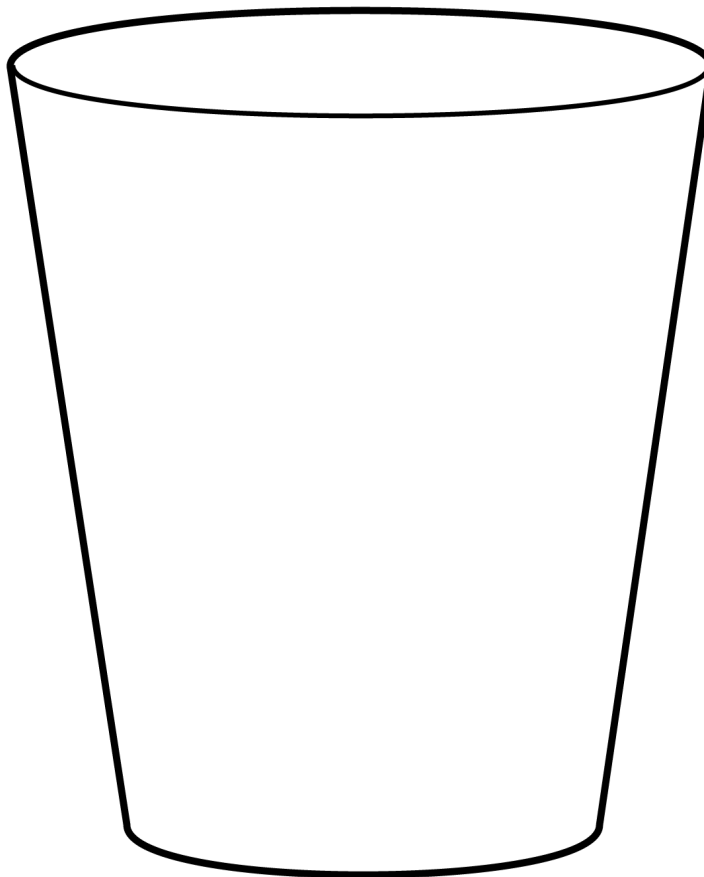
Measuring Density Diagram

Imagine pouring all four solutions into the same clear container without stirring. If the solutions did not mix, they would settle into layers based on their densities.

In the container below:

- Shade the container to show where each solution would settle.
- Label each layer with the correct solution name.
- Place the least dense solution at the top and the most dense solution at the bottom.

Then, explain why the solutions would arrange themselves this way.



Conclusion *Complete the statements:*

As salinity increases, mass _____.

As salinity increases, density _____.



MOVEMENT BASED ON DENSITY

SOLUTION COMBINATION	OBSERVATION (Look carefully: Does the solution float, sink, or stay in the middle?)
Green Ice (non-saline) & tap water	
Red Ice (25% saline) & tap water	
Yellow Ice (50% saline) & tap water	
Blue Ice (100% saline) & tap water	

Things to Ponder _____

1. How does the density of the water influence its behavior? _____

2. What causes currents in the ocean? _____

3. What happens to denser water in the ocean? _____

4. What happens to less dense water in the ocean? _____

5. You observed that water with different densities moves in different ways—some sinks, some rise, and some stay in place. In the ocean, this same idea happens on a much larger scale. When water moves because of density differences, it creates currents.

What does the movement of different densities of water influence? (Hints: What does moving water carry with it? How could moving water affect temperature? What might rising water bring from the bottom? How could this affect ocean animals?) _____

Lesson 2: Density, Salinity, and Water Behavior (2 Days)

Getting Started

✿ Ideas to Think About

- How do the properties and structure of water impact Earth's systems and support life on Earth?

Things to Know

- The **density** of a material is its mass per unit volume. Density is mass divided by volume ($D = \frac{M}{V}$).
- Substances have different densities depending on their content. For example, tap water is less dense than salt water.
- Mass and weight are not the same - mass measures the amount of matter in an object, and weight measures how heavy the object is.
- **Salinity** is a measure of how much salt is in water. Salinity and temperature influence density.
- Differences in salinity and density affect how water moves and mixes.

Reading and Questions

1. What are the two main factors that affect the density of water?

The two main factors that affect the density of water are temperature and salinity.

2. Why does cold water usually sink below warm water in lakes and oceans?

Cold water sinks because its molecules move more slowly and stay closer together, making it more dense than warm water. Warm water rises because it is less dense.

3. How can small differences in temperature and salinity lead to large-scale movement of water around Earth?

Changes in temperature and salinity create water with different densities. Denser water sinks while less dense water rises. These movements create currents that move heat, nutrients, and water throughout the oceans, helping regulate climate and support life on Earth.

⦿ Skills

- Develop and use a model to describe how particles interact in a solution. (MS-PS1-1)
- Analyze and interpret data on the properties of substances before and after substances interact to determine if a chemical reaction has occurred. (MS-PS1-2)
- Plan and carry out investigations to explore how adding a substance changes the mass and density of water. (Science & Engineering Practice)
- Use mathematical thinking to calculate density and identify patterns in data. (Science & Engineering Practice)
- Analyze and interpret data from investigations to explain how salinity affects water behavior. (Science & Engineering Practice)
- Analyze evidence to explain observations, make inferences and predictions, and develop the relationship between evidence and explanation.
- Observe, collect, organize, and analyze data.
- Use oral and written language to communicate findings.

- Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Introducing the Lesson

Your child is building on his understanding of water from Lesson 1 by exploring how density and salinity affect water behavior. He will investigate how adding salt changes the properties of water and influences whether it sinks, floats, or forms layers. Through hands-on activities and observations, he will begin to understand how these concepts explain real-world phenomena like ocean currents and water movement.

Activities

Activity 1: Making Density Solutions - Part 1

Here, your child explores what happens when salt is mixed with water. He observes that the salt dissolves and spreads throughout the water, forming a solution. He also learns to identify the signs of a chemical reaction and uses his observations to determine that no chemical reaction occurs—this is a physical change. This builds foundational understanding for future investigations into density and water behavior.

Special Note: Your child will need to save the saltwater solution he creates, as it will be used in additional activities later today and tomorrow. Please also note that this activity involves using the stove, so **adult supervision is required** when heating the water.

Answer Key:

1. Salt dissolved in the water and became less visible as it mixed in.
2. It spread out in the water. The salt did not actually disappear. It broke apart into tiny particles and spread evenly throughout the water.
3. None of these
4. physical reaction. No signs of a chemical reaction were observed. The salt simply dissolved, and no new substance was formed.
5. The salt broke into tiny particles and spread throughout the water, forming a solution.
6. Water is made of tiny moving particles that can surround and pull apart the salt particles, allowing them to spread evenly through the water.

Activity 2: Making Density Solutions - Part 2

Here, your child uses the saltwater solution he created to make new solutions with different salinity levels (0%, 25%, 50%, and 100%). He measures and mixes carefully, building skills in following procedures and understanding how changing the amount of salt affects a solution. He then creates colored ice cubes from each solution, which will be used in tomorrow's investigation to explore density and water behavior.

Special note: He needs his 100% solution and the 4 labeled cups to mix more solutions tomorrow.

Day 2

Activity 3: Water and Its Behavior

Here your child measures and compares the mass and density of different saltwater solutions. He observes that as more salt is added, the mass and density increase, even when the volume stays the same. He uses this data to predict how water of different densities behaves, building a deeper understanding of how salinity affects water movement, an idea that will be explored further in the next activity.

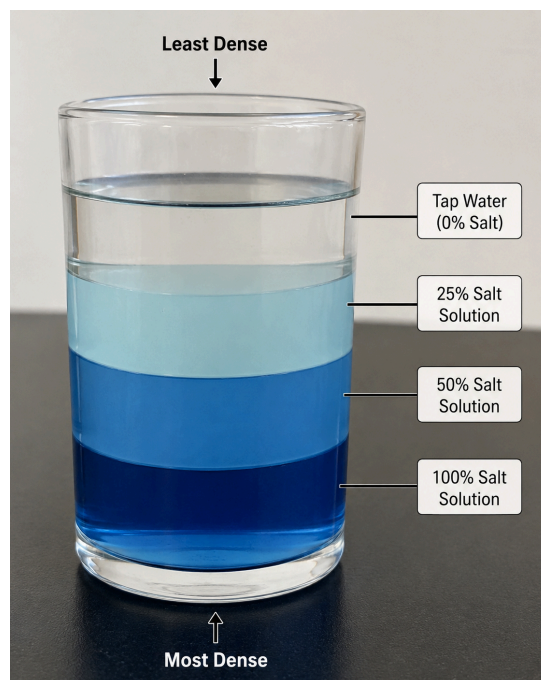
Your child's mass measurements and density calculations should be similar to the values shown in the table below, but it is completely normal if their numbers are somewhat different. Small differences can happen for many reasons during hands-on experiments.

For example, your child may not have measured exactly 100 milliliters each time, or a small amount of liquid may have been spilled or left behind in a measuring cup. The scale may also not have been perfectly zeroed, which can affect the mass reading. In addition, not all of the salt may have fully dissolved, or the mixtures may not have been stirred evenly, which can change how the mass is distributed in the solution.

What matters most is not getting the exact same numbers, but noticing the pattern: as more salt is added, the mass increases, and the density increases. If your child's data shows this general trend, then the experiment was successful, and the scientific idea was understood.

Activity 3 Table			
Solution Name	Solution Mass (grams)	Solution Volume (mL)	Solution Density (g/mL)
Tap water	100	100	1
25% solution	105	100	1.05
50% solution	110	100	1.1
100% solution	120	100	1.2

- **Measuring Mass Question:** Sample Answer: As salinity increased, the mass of the solutions increased. Even though each solution had the same volume (100 mL), the saltwater solutions contained more matter because dissolved salt was added to the water. The 100% salt solution had the greatest mass, while the tap water had the smallest mass. My measurements showed that solutions with higher salinity had higher masses.
- **Final Conclusion:** As salinity increases, mass increases. As salinity increases, density increases.



Activity 4: Density Variables

This activity explores how differences in water density affect movement. Your child observes how solutions with varying amounts of salt either float, sink, or remain suspended, and connects these patterns to how water moves in the ocean. Through this investigation, he begins to understand how density drives currents and influences temperature, nutrients, and marine life.

Answer Key:

Movement Based on Density	
Solution Combination	Observation
Green Ice (non-saline) & tap water	Floats on top
Red Ice (25% saline) & tap water	Floats with a little bit of water on top of it
Yellow Ice (50% saline) & tap water	Sinks to the bottom
Blue Ice (100% saline) & tap water	Sits at the bottom

Questions to Ponder:

How does the density of the water influence its behavior? (The denser water sinks to the bottom or remains at the bottom.)

What causes currents in the ocean? (Differences in water density cause some ocean currents. Density differences can be caused by changes in salinity and temperature.)

What happens to denser water in the ocean? (It sinks to the bottom.)

What happens to less dense water in the ocean? (It rises to the top.)

What does the movement of different densities of water influence? (Answers will vary. Moving water can carry heat and nutrients from one place to another. This movement can affect water temperature, the availability of nutrients, ocean currents, and where marine organisms can live and find food.)

Wrapping Up

In this lesson, your child investigated how adding salt to water changes its mass and density. He observed that increasing salinity makes water more dense and used this understanding to explain why some water sinks while other water floats. Through hands-on activities and data analysis, he developed a clearer understanding of how density affects water behavior. This prepares him for the next lesson, where he will explore how these differences drive ocean currents and influence Earth's climate.

Questions to Discuss

- Why does adding salt to water make it more dense? (Answer: Adding salt increases the amount of matter (mass) in the same amount of space (volume). Since density is mass divided by volume, increasing the mass makes the water more dense.)
- How does density help explain why some water sinks and some water floats? (Answer: Water that is more dense sinks below water that is less dense. This is why saltier (more dense) water settles at the bottom, while less salty (less dense) water stays on top.)

Things to Review

- Review how density and salinity affect water behavior.