Activity Description & Estimated Class Time

Over the course of one 50-minute class period, students will explore how temperature and salinity affect density and drive major ocean currents.

Correlations to NC Science Standards

ESS.8.2.2 Use models to explain how temperature and salinity drive major ocean currents and how these currents impact climate, ecosystems, and the distribution of nutrients, minerals, dissolved gases, and life forms.

Learning Target

Students will demonstrate knowledge and understanding of the relationship among temperature, salinity, and density and how it impacts ocean currents.

Brief Science Background

Water can dissolve many materials. Saltwater is simply water that has salt dissolved in it. The ocean is salty because of dissolved chemicals eroded from the Earth's crust and washed into the sea. Solid and gaseous ejections from volcanoes, suspended particles swept to the ocean from the land by onshore winds, and materials dissolved from sediments deposited on the ocean floor have also contributed. Oceans have many different nutrients, minerals, and gases (especially nitrogen, oxygen and carbon dioxide) that are dissolved in them. Since there are more things in the same amount of space, saltwater is more dense than freshwater.

Other factors such as temperature can change the density in fresh and salt water. Adding heat to a liquid adds energy, causing the molecules in the warm liquid to move faster than molecules in the cold liquid. When these molecules move, they get farther apart making the liquid less dense.

Part 1 — Saltwater and Freshwater

Materials

Materials for the whole class

- 9-oz. tall cups
- salt
- blue food coloring
- taster spoons
- 1-oz. cups
- water (provided by teacher)

Materials for groups of 2 students

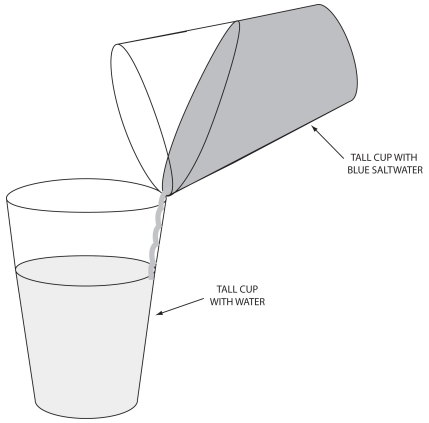
- 2 9-oz. tall cups
- 1 1-oz. cup of salt
- blue food coloring (shared amongst 4 students)
- 1 taster spoon
- 2 ocean currents student activity sheet (SD1)
- water (provided by teacher)

Preparation

1. Fill one 1-oz. cup 3/4 full of salt for each group.
2. Set out all the remaining materials for groups of two.

Procedure

1. Give each student an ocean currents student activity sheet (SD 1) and ask students to predict will happen if they mix freshwater and saltwater.
2. Have students fill up both tall cups 2/3 full with water.
3. Have students pour the 1-oz cup of salt into one cup. In the same cup place one to two drops of blue food coloring and stir with the taster spoon. Let the cups sit for 30 seconds.
4. After the cups have sat, students should **gently** pour some of the saltwater down the inside edge of the cup into the water.
   Demonstrate how to do this for the students. The blue salt water is more dense and will sink to the bottom of the cup, creating a nice layer.



5. Have students observe the cup from the side, draw what they see on the student activity sheet, describe their observations, and compare their results to their prediction. To clean up, rinse and dry the cups and taster spoon to be reused.

Part 2 — Temperature

Materials

Materials for the whole class

- 9-oz. cups
- salt
- blue food coloring
- taster spoons
- 1-oz. cups
- ice cubes
- water (provided by teacher)
- thermohaline circulation reading (SD 2)

Materials for groups of 2 students

- 2 9-oz. cups
- 1 1-oz. cup of salt
- blue food coloring (shared amongst 4 students)
- 1 taster spoon
- 2-3 ice cubes
- 2 ocean currents student activity sheet (SD 1) from previous activity
- water (provided by teacher)

Preparation

1. Fill one 1-oz. cup full of salt for each group.
2. Set out all the remaining materials for groups of two.

Procedure

1. Have student take out their ocean currents student activity sheet (SD 1) and ask students to predict will happen if they mix warm saltwater and cold saltwater.
2. Have students fill up one tall cup 2/3 full with water.
3. Have students pour **half of the 1-oz cup of salt** into one cup and stir with the taster spoon.
4. In the other tall cup, have students place 2-3 ice cubes in the cup and fill up 2/3 full with water. In the same cup, pour the rest of the salt in to the water, place one to two drops of blue food coloring and stir with the taster spoon. Let the cups sit for 30 seconds.
5. After the cups have sat, students should **gently** pour some of the cold saltwater down the inside edge of the cup into the warm saltwater.
   The blue, cold, saltwater is more dense and will sink to the bottom of the cup creating a nice layer.
6. Have students observe the cup from the side, draw what they see on the student activity sheet, describe their observations, and compare their results to their prediction.

Content Connection

1. Have students answer question 4 on their student activity sheet (SD 1).
   Ice-cold saltwater will be more dense than warm saltwater as the molecules in warm saltwater have more energy, causing the molecules to move farther apart, making the liquid less dense.
2. Project the thermohaline circulation reading (SD 2). This is adapted from the NOAA (National Oceanic and Atmospheric Administration) website which also provides a graphic. Read together as a class and ask students, "As the polar ice caps continue to melt due to climate change, how do you think it will impact the ocean currents?"
   As the polar ice caps melt, more freshwater is released into the ocean. This makes the water less salty and less dense, which slows down the deep-ocean currents.

SD 1

Ocean Currents Student Activity Sheet

Name:

Saltwater and Freshwater

1. Predict what will happen when you mix freshwater and saltwater.

2. Draw what you see and document your observations.

3. Compare your results to your prediction.

Temperature

1. Predict what will happen when you mix warm saltwater and cold saltwater.

2. Draw what you see and document your observations.

3. Compare your results to your prediction.

4. Adding heat to a liquid adds energy, causing the molecules in the warm liquid to move faster than molecules in the cold liquid. When these molecules move, they get farther apart making the liquid less dense. Based on this information, compare the density of warm saltwater and ice-cold saltwater.

SD 2

Thermohaline Circulation

Winds drive ocean currents in the upper 100 meters of the ocean's surface. However, ocean currents also flow thousands of meters below the surface. These deep-ocean currents are driven by differences in the water's density, which is controlled by temperature (thermo) and salinity (haline). This process is known as thermohaline circulation.

In the Earth's polar regions ocean water gets very cold, forming sea ice. As a consequence the surrounding seawater gets saltier, because when sea ice forms, the salt is left behind. As the seawater gets saltier, its density increases, and it starts to sink. Surface water is pulled in to replace the sinking water, which in turn eventually becomes cold and salty enough to sink. This initiates the deep-ocean currents driving the global conveyer belt.