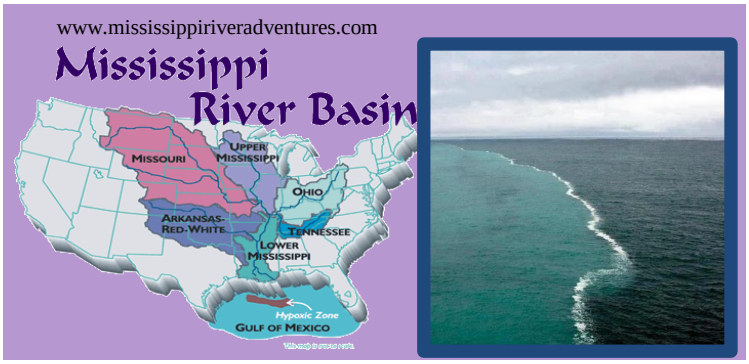
Title: ***Depths of Density Project***
Author: ***Nicole Cotten***
Organization: LUMCON
Dept.: Marine Education

Background Information

Water density, and the factors that control it, is an important way to establish different masses of water. Within the Gulf region, water density is used to identify the Mississippi River plume coming into the Gulf of Mexico. Density is defined in a qualitative manner as the measure of the relative "heaviness" of objects with a constant volume. Density may also refer to how closely "packed" or "crowded" the material appears to be (Example: Styrofoam vs. ceramic cup). Understanding density leads to an understanding of how layers of water with different properties interact with one another, how organisms move in the water column, how different chemicals (example: pollutants) behave in the water column as well as how sediment will be transported in the water column. Understanding density is even more important to understand when studying areas of freshwater flowing into a salty ocean.



Louisiana State Standards (Grade-Level Expectations)

SI GLE: Predict and anticipate possible outcomes (SI-E-A2).
Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2).
Write and defend a conclusion based on logical analysis of experimental data (SI-H-A6) (SI-H-A2).

SI GLE: Select and use developmentally appropriate equipment and tools and units of measurement to observe and collect data (SI-E-A4).
Select and use appropriate equipment, technology, tools, and metric system units of measurements to make observations (SI-M-A3).

SI GLE: Choose appropriate models to explain scientific knowledge or experimental results (e.g., objects, mathematical relationships, plans, schemes, examples, role-playing, computer simulations) (SI-H-A4).

SI GLE: Pose questions that can be answered using students' own observations and scientific knowledge (SI-E-A1)
Generate testable questions about objects, organisms, and events that can be answered through scientific investigations (SI-M-A1).
Describe how investigations can be observation, description, literature survey, classification, or experimentation (SI-H-A2)

SI GLE: Use a variety of appropriate forms to describe procedures and express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibits, portfolios) (SI-E-A6).

Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-3).
Plan and record step-by-step procedures for a valid investigation, select equipment and materials, and identify variables and controls (SI-H-A2).

SI GLE: Use computers and/or calculators to analyze or interpret quantitative data (SI-M-A3).
Utilize mathematics, organizational tools, and graphing skills to solve problems (SI-H-A3).

PS GLE: Order objects by weight/mass (PS-E-A1).
Measure a variety of objects in metric system units (PS-M-A1).
Measure the physical properties of different forms of matter in metric system units (e.g., length, mass, volume, temperature) (PS-H-A1).

Ocean Literacy Principles

Principle 1c: Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.

Principle 1e: Most of Earth's water (97%) is in the ocean. Seawater has unique properties: it is saline, its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. The salt in seawater comes from eroding land, volcanic emissions, reactions at the seafloor, and atmospheric deposition.

Principle 1g: The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.

Key Terms

Temperature**:** a measure of the average kinetic energy of the atoms or molecules of a substance.
Salinity**:** concentration of dissolved salts in ocean water.
Volume**:** the amount of space, measured in cubic units, that an object or substance occupies.
Mass**:** a numerical measure of the amount of matter in an object or substance. Density**-** mass per unit volume.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Mass vs. Weight**:** Although the terms mass and weight are used almost interchangeably, there is a difference between them. **Mass** is a measure of the quantity of matter, which is constant all over the universe. **Weight** is proportional to mass but depends on location in the universe. Weight is the force exerted on a body by gravitational attraction (usually by the earth).

Time Requirement

The teacher should gather the different water types before the activity (i.e., seawater, freshwater, ice bath). If seawater is unavailable, then mix salt into tap water; the point of this lesson is to establish a difference in density, therefore, attaining seawater is not mandatory. The teacher should also add food coloring to the water prior to the activity. Once the water is made, the students will measure salinity, temperature, mass, and volume of the water which should take 15 minutes. The physical part of the activity, showing the difference in densities and calculating the density, will only take 3 minutes.

Materials

2.5 mL glass vials
Index cards, laminated
Triple beam or electronic scale
Graduated cylinder
Food coloring
Seawater or salt mixed with water
Tap water
Refractometer
Thermometer
1 gallon milk jugs (2)
Beakers
Calculator

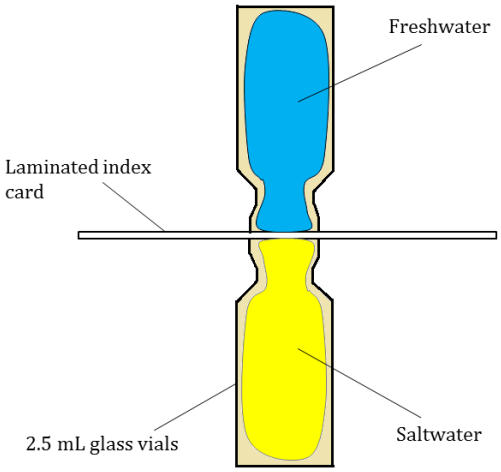
Lesson Description

Creating the Oil Transportation Project

1. Prepare the jugs of saltwater and freshwater.
2. Add yellow food coloring to the saltwater and blue food coloring to the freshwater.

Methodology

Divide students in appropriate sized groups; this activity can be adjusted to use smaller or larger groups. Once the water is prepared, have the groups pour 200 mL into their beaker to measure salinity, temperature, volume, and mass. Also, have the students calculate the density of the two water samples using a calculator. Notify the students to write down all observations on the sheets provided. After all the parameters have been recorded, allow the groups to pipette saltwater and freshwater into two 2.5 mL glass vials; instruct the students to fill each vial completely. Place a laminated index card on top of the saltwater vial, then invert the freshwater sample and place upon the same card in the same position as the saltwater vial. Slowly remove the card and record observations. Grasp both vials and turn them upside down, so that the freshwater vial is on the bottom; record the observations.



Graduated cylinder

Electronic scale

Thermometer

Refractometer

Standard Evaluation (Student Deductions)

1. Is saltwater or freshwater more dense? Explain why.
2. Which is denser, cold or warm water? Explain why.
3. Draw a diagram of how water might layer when a river enters the ocean.
4. How might oil from in the earth's crust move in the ocean? Explain.

The evaluation can be in the form of a test, essay, questions and answers worksheet, or any other mode of measuring retainment or comprehension of material.

The Depths of Density

Background

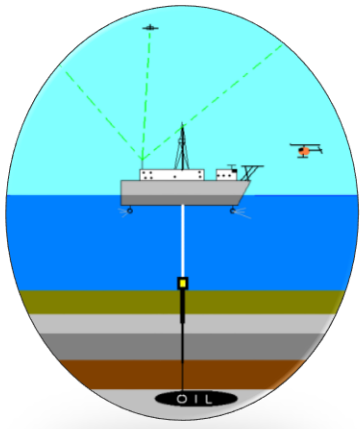
Marine scientists study the geology, chemistry, biology and/or physical aspects of the ocean. All of these areas are directly affected by the physical and chemical properties of water, and therefore a basic understanding of the physical and chemical properties of water is a must in understanding all processes of the ocean.

***DENSITY** is a physical property of any type of matter, as each element and compound has a unique density associated with it. Density is defined in a qualitative manner as the measure of the relative "heaviness" of objects with a constant volume. Density may also refer to how closely "packed" or "crowded" the material appears to be (Example: Styrofoam vs. ceramic cup). Understanding **density** leads to an understanding of how layers of water with different properties interact with one another, how organisms move in the water column, how different chemicals (example: pollutants) behave in the water column as well as how sediment will be transported in the water column. Understanding density is even more important to understand when studying areas of freshwater flowing into a salty ocean.*

*The **density** of water is a function of the physical properties temperature, salinity and pressure.*

The Mississippi Rivers delivers a volume of 700,000 - 200,000 cubic feet of freshwater to the Gulf of Mexico off of Louisiana's coast per second!!

In 2012, Louisiana produced an estimated 238,436,093 barrels of crude oil and condensate. (LA Dept. of Natural Resources)



The Depths of Density Data Sheet

Record your observations when mixing on the back of the Data Sheet

Yellow Solution

Temperature _____ *°C*

Salinity _____ *psu*

Volume _____ *mL*

Mass _____ *g*

Blue Solution

Temperature _____ *°C*

Salinity _____ *psu*

Volume _____ *mL*

Mass _____ *g*