Title: <u>Conductivity of Ocean Water</u>

(Water Chemistry)

Grade Levels: 6-8

Introduction: We all know that ocean water tastes salty because it contains many dissolved salts of different elements. These salts are similar to the salt that we use to season our food. In the water, these salts are separated into ions of chloride, sodium, sulfur, magnesium, and calcium. These ions are small particles of these elements that can carry electricity. For this reason, it is dangerous to handle electrical appliances in the water, because the water solutions can conduct electricity.

In this activity, students will investigate a property of water called conductivity. Conductivity is the ability of salt-water solutions to conduct electricity. To study the conductivity of salt water, the students will use the TI calculator and the CBL (Calculator Based Laboratory) in conjunction with a conductivity probe.

Learner Objectives:

- The student will be able to describe some of the components of seawater.
- The student will be able to describe how the components of seawater change the properties of the water.
- The student will be able to explain how salt dissolved in water can cause water to conduct electricity.

Florida Sunshine State Standards: Science: SC.A.1.3.1,GLE 1, SC.H.1.3.2, GLE 1; SC.H.1.3.5, GLE(s) 1, 2, 3; Math: MA.D.1.3.1 MA.D.1.3.2

Competency-Based Curriculum: Science: M/J1-I.1.A, I.2.A, I.3.A, I.8.A, I.1.B, I.2.B, IV.1.A, M/J2-I.3.A, M/J2-I.8.B, I.1.B, I.2.B, M/J3-I.3.A, I.8.A, I.1.B, I.2.B, III.2.A

Materials:

CBL System	100-mL beaker
TI Graphing Calculator	distilled water
Vernier Conductivity Probe	stirring rod
Vernier adapter cable	utility clamp
TI-Graph Link	ring stand

sodium chloride solution (1.0 M (5.85 g of NaCl per 100 ml))

Figure 1

Activity Procedures:

1. Obtain and wear goggles.
2. Get 40 mL of distilled water in a clean 100-mL beaker.
3. Assemble the conductivity probe, utility clamp, and ring stand as shown in Figure 1. Be sure the probe is clean and dry before beginning the experiment.
4. Prepare the conductivity probe for data collection.
   - Plug the conductivity probe into the adapter cable in Channel 1 of the CBL.
   - Set the selection switch on the amplifier box of the probe to the 0-2000 μS range.
   - Use the link cable to connect the CBL System to the TI Graphing Calculator. Firmly press in the cable ends.
5. Turn on the CBL unit and the calculator. Start the CHEMBIO program and proceed to the MAIN MENU.
6. Set up the calculator and CBL for a conductivity probe and a calibration of 0 to 2000 μS.
   - Select SET UP PROBES from the MAIN MENU.
   - Enter Ò1Ó as the number of probes.
   - Select CONDUCTIVITY from the SELECT PROBE menu.
   - Enter Ò1Ó as the channel number.
   - Select USE STORED from the CALIBRATION menu.
   - Select H 0-2000 MICS from the CONDUCTIVITY menu.
7. Set up the calculator and CBL for data collection.
   - Select COLLECT DATA from the MAIN MENU.
   - Select TRIGGER/PROMPT from the DATA COLLECTION menu.Follow the directions on the calculator screen to allow the system to warm up, then press “Enter”.

Activity Procedures (Cont'd):

8. Before adding any salt solution:
   - Carefully raise the beaker and its contents up around the conductivity probe until the hole near the probe end is completely submerged in the solution being tested. Important: Since the two electrodes are positioned on either side of the hole, this part of the probe must be completely submerged as shown in Figure 1.
   - Monitor the conductivity of the distilled water displayed on the CBL screen for 4-5 seconds (the unit of conductivity is the microsiemens, μS).
   - Press "Trigger"on the CBL, and then enter "0" (the volume, in drops). The conductivity and volume values have now been saved for the first trial. This gives the conductivity of the water before any salt solution is added.
   - Lower the beaker away from the probes.
   - Record the conductivity value in your data table (round to the nearest 1 μS).
9. You are now ready to begin adding salt solution.
   - Select MORE DATA.
   - Add 1 drop of salt solution to the distilled water. Stir to ensure thorough mixing.
   - Carefully raise the beaker and its contents up around the conductivity probe until the hole near the probe end is completely submerged in the solution being tested.
   - Briefly swirl the beaker contents. Monitor the conductivity of the solution for 4-5 seconds.
   - Press "Trigger", and then enter "1" (the volume, in drops). The conductivity and volume values have now been saved for the second trial.
   - Lower the beaker away from the probes.
   - Record the conductivity value in your data table.
10. Repeat the Step 9 procedure, entering "2" this time.Record the conductivity value in your data table.
11. Continue this procedure, adding 1-drop portions of salt solution, measuring conductivity, and entering the total number of drops added until a total of 10 drops have been added.
12. Select STOP AND GRAPH from the DATA COLLECTION menu when you have finished collecting data. Examine the data points along the displayed graph of conductivity vs. volume. As you move the cursor right or left, the volume (X) and conductivity (Y) values of each data point are displayed below the raph. Confirm the conductivity and volume data pairs you recorded in your data table.
13. If available, use the TI-Graph Link cable and program to transfer the graph of conductivity vs. volume to a Macintosh or IBM-compatible computer. Print a copy of the graph.
14. Dispose of the beaker contents as directed by your teacher.

Data Table:

Drops	Conductivity (µS)
0	____________________
1	____________________
2	____________________
3	____________________
4	____________________
5	____________________
6	____________________
7	____________________
8	____________________
9	____________________
10	____________________

Processing the Data:

1. If the graph link and computer is not available, plot a graph of the conductivity vs. drops data on graph paper. Label both axes and show correct units on either the printed or the hand-made graph. Label tickmarks with the numerical values they represent.

Assessment:

The students should prepare a lab report, which should include all major parts of a lab report plus the graph and the answers to the following questions:

1) Describe the appearance of your graph. What does this indicate? Explain
2) Describe the change in conductivity as the concentration of the NaCl solution was increased by the addition of the drops.What kind of relationship does there appear to be between conductivity and concentration?
3) How do you think that the ability to conduct electricity will change if you use other types of salts?
4) What differences do you observe between the prepared salt solution and real seawater?

Activity Extensions:

1. Obtain seawater and water from other sources and try a similar experiment with these samples instead of the prepared NaCl solution.
2. Compare your results and those of other obtained when samples from more than one source are tested.
3. Interdisciplinary: Design a poster for swimming pool or the beach explaining the dangers of swimming during lightning storms (Art, Physical Education).

Home Learning Activity:

Allow students to bring in samples of water from their homes, the ocean, and surrounding areas to measure and compare their conductivity in the classroom.

Vocabulary: ions, chloride, sodium, magnesium, calcium, salt

References:

Holmquist, D.D., Randall, J., Volz, D.L., (1995) Chemistry with CBL, Portland, OR; Vernier Software.

Glencoe (2000) Science Voyages, Westerville, OH; Glencoe/Mc Graw Hill.

Conductivity of Ocean Water

Reading Passage

Seventy percent of Earth's surface is covered by ocean water. However, water from the ocean is different from drinking water. It tastes salty because the ocean contains many dissolved salts. In these waters, these salts are separated into chloride, sodium, sulfur, magnesium, calcium, and potassium.

These salts come from rivers and groundwater that slowly dissolve elements such as calcium, magnesium, and sodium from rocks and minerals. Rivers carry these elements to the oceans. Erupting volcanoes add elements, such as sulfur and chlorine, to the atmosphere and oceans.

The most abundant elements in seawater are sodium and chlorine. As rivers flow to the ocean, they dissolve sodium along the way. Volcanoes add chlorine gas. These elements also make up most of the salt in seawater. The proportion and amount of dissolved salts in seawater remain nearly constant and have stayed about the same for hundreds of millions of years.

The salt in seawater gives the water special properties. One of the properties is that the salt makes water more dense (or heavier). Another physical property of water, which also changes, is the property of conductivity. Conductivity is the ability of salt-water solutions to conduct electricity. The tiny particles of salt in the water allow electricity to move through the water.

Conductivity is a very important property and one, which we all must be very aware of. When we hear that it is dangerous to touch electrical equipment when we are wet, the reason is because the water can conduct the electricity from the appliance into our bodies. As a result of this, we can get an electric shock, which in some cases could even be fatal.

Because we are surrounded by water and use water extensively every day, it is very important that we learn about all the different properties of water and its solutions and how these can affect our lives.

Conductivity of Ocean Water

FCAT Questions

Directions: Read the passage, then answer the questions. Answer multiple choice questions by circling the letter of the answer that you select. Write your answer to the “Read,Think, and Explain” question on the lines provided.

1. Which are the most abundant elements in seawater?

   A. Potassium and sulfate
   B. Calcium and fluoride
   C. Sodium and chlorine
   D. Aluminum and sulfur

Answer: C

2. What word describes the ability of solutions to conduct electricity?

   A. Conductivity
   B. Transportability
   C. Electrical shock
   D. Reflectivity

Answer: A

3. According to the information given, what happened to the proportion and amount of dissolved salts in ocean water through the years?

   A. Increased during the years
   B. Decreased during the yeara
   C. Remain the same for hundreds of millions of years
   D Change every 100 years.

Answer: C

4. Explain how sodium and chloride get into seawater.

READ
THINK
EXPLAIN

Title: <u>How Salty Is Our Water?</u>

(Water Chemistry)

<u>Grade</u>(s): 6-7

<u>Introduction</u>: Corals require a relatively constant environment. However, due to the proximity to the surface of the ocean, the salinity of the water may change with precipitation. The water, around Bermuda has a salinity of 37 parts per thousand. In contrast, most of the Atlantic Ocean has a salinity of 35 parts per thousand. In the fall and winter months the amount of precipitation increases significantly, and as a result, the salinity of the water surrounding Bermuda decreases especially around the shoreline due to runoff. Corals can tolerate some variation in the salinity of their environment.

In this activity, students will investigate different methods that they can use to determine the salinity of water samples. The Sea Test measures specific gravity and provides students with the concentration of dissolved salts (parts per thousand or ppt). Conductivity provides students with a measure of salinity based upon the amount of current that is able to flow through the solution. The colourimetric determination provides students with a measure of salinity using a simple titration and colour chart. Once these different determinations are completed, students can then compare the results of these methods.

<u>Learner Objective</u>(s):

- The student will be able to determine the salinity of different samples of water using a variety of methods.
- The student will be able to describe the chemical properties of water.
- The student will be able to explain differences between salt water and fresh water.

<u>Florida Sunshine State Standards</u>: Science: SC.A.1.3.1/ SC.A.1.3.4 Math: MA.B.3.3.1

<u>Competency Based Curriculum</u>: Science: M/J-3-III-2-A; Math: M/J-I-III-2-A, Math: M/J-3-II-9-B

Materials:

Aquarium Systems Sea Test (available from local pet shop)
Conductivity meter (i.e., Keltec Soluble Salts Analyzer)
Colourimetric Salinity Test Kit
Six 250 ml beakers
100 ml graduated Cylinder
Glass rod
Wax pencil
Salt
Scale

Activity Procedures:

1. Using the wax pencil, label the beakers 0%, 1%, 2%, 3%, 4%, and 5%.
2. Using the graduated cylinder, measure 100 ml of water and pour it into each of the 250 ml beakers.
3. Set aside the beaker of water labeled 0%.
4. Measure 1 g of salt and dissolve in the beaker labeled 1%. Stir the mixture with the glass rod until all of the salt is dissolved.
5. Repeat step #4 with each of the other appropriate beakers using 2g, 3g, 4g, and 5g of salt.
6. Take a sample of the plain water from the 0% beaker and measure the conductivity (use the conductivity meter) and record your data in table form.
7. Pour the sample back into the original beaker.
8. Pour the water into the Sea Test apparatus. Be careful not to trap bubbles. If bubbles are present, tap the side of the container to remove them.
9. Record the salt concentration of the solution. Remember: 0% is not readable.
10. Using the Colourimetric salinity Test Kit, take a sample of the 0% solution and add the appropriate reagents. The water will then change color.
11. Compare the final color of the solution with the color chart provided to determine the salinity of the solution.
12 Repeat steps 6-11 for each of the 5 solutions.
13. Students can plot the data (conductivity vs. concentration; specific gravity vs. concentration; ppt vs. concentration)
14. Students can interpolate their curves to find values corresponding to 35 ppt and 37 ppt.

Student Assessment:

Allow student to answer critical thinking skills questions assigned by the teacher.

a. Is it easier to float in salt water than fresh water? Explain.
b. Discuss the pros and cons of each method used in the activity and how the results for each solution compare among the different methods used.

Ask student to interpret data plotted in step #13 of the Activity Procedures.

Activity Extension(s):

1. Challenge students to create a model that demonstrates the increasing salinity of a saltwater solution as water evaporates (Chemistry).
2. Design an experiment that tests the effects of reduced salinity on brine shrimp (Biology/Ecology).
3. Calculate the percent of chloride in different solutions of water assigned by the teacher (Math).

Home Learning Activity:

Allow students to bring in samples of water from their homes and their surrounding areas. The salinity of these samples can then be measured and compared.

Attachment: Salinity Data Table (completed during Activities Procedures)

%	Colourimetry	Conductivity	Sea Test Apparatus	Color
0				
1				
2				
3				
4				
5				

Vocabulary: salinity, precipitation, conductivity, colourimetric, simple titration

References/Related Links:

www.educationworld.com

http://www.odysseyexpeditions.org/oceanography.html

http://seawifs.gsfc.nasa/OCEAN_PLANET/html

How Salty Is Our Water?

Reading Passage

Seawater is a dilute solution of several salts derived from weathering and erosion of continental rocks. The salinity of seawater is expressed in terms of total dissolved salts in parts per thousand parts of water. Salinity varies from nearly zero in continental waters to about 41 parts per 1000 in the Red Sea, a region of high evaporation, and more than 150 parts per 1000 in the Great salt Lake. In the main ocean, salinity averages about 35 parts per 1000, varying between 34 and 36. The major cations, or positive ions present, and their approximate abundance per 1000 parts of water are as follows: sodium, 10.5; magnesium, 1.3; calcium, 0.4; and potassium, 0.4 parts. The major anions, or negative ions, are chloride, 19 parts per 1000, and sulfate, 2.6 parts. These ions constitute a significant portion of the dissolved salts in seawater, with bromide ions, bicarbonate, silica, a variety of trace elements, and inorganic and organic nutrients making up the remainder. The ratios of the major ions vary little throughout the ocean, and only their total concentration changes.

Salinity refers to the total amount of dissolved substances. Salinity is usually expressed in terms of its specific gravity, the ratio of a solution's weight to weight of an equal volume of distilled water. Because water expands when heated (changing its density), a common reference temperature of 59F degrees is used. salinity is measured with a hydrometer, which is calibrated for use at a specific temperature (e.g., 75F degrees is common). Some freshwater fish tolerate, or even prefer, a small amount of salt because it stimulates slime coat growth. Moreover, parasites do not tolerate salt at all. Thus, salt in concentrations of up to 1 tablespoon per 5 gallons can actually help prevent and cure parasitic infections. On the other hand, some species of fish do not tolerate any salt well. Scaleless fish and some Corydoras catfish are far more sensitive to salt than most freshwater fish. Add salt only if you are certain that all of your fish tank's inhabitants prefer it or can at least tolerate it.

How Salty Is Our Water

FCAT Questions

Directions: Read the passage, then answer all the questions below. Answer multiple-choice questions by circling the letter of the answer that you select. Write your answer to the “Read, Think, and Explain” question on the lines provided.

1. The salinity of seawater is expressed in terms of::

   A. Meg/liter
   B. Degrees C
   C. PPT
   D. Gallons of sodium chloride

   Answer: C

2. What is made from weathering and erosion of continental rocks?

   A. Ions
   B. Seawater
   C. Pollution
   D. Thermocline

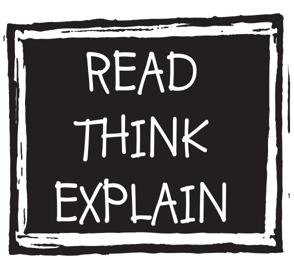
   Answer: B

3. Salinity is best measured by a::

   A. Hydrometer
   B. Hygrometer
   C. Plethysmograph
   D. Sodium calorimeter

   Answer: A

4. Describe the chemical properties of water.



PROPERTIES OF PURE SODIUM CHLORIDE

Molecular weight - NaCl 58.4428

Atomic Weight - Na 22.989768 (39.337%)

Atomic Weight - Cl 35.4527 (60.663%)

Eutectic Composition - 23.31% NaCl

Freezing Point of Eutectic Mixture - -21.12 Degrees C (-6.016 Degrees F)

Crystal Form - Isometric, Cubic

Color - Clear to White

Index of Refraction - 1.5442

Density or Specific Gravity - 2.165 (135 lb/cubic ft)

Bulk Density, approximate (dry, ASTM D 632 gradation) 1.154 (72 lb/cubic ft)

Angle of Repose (dry, ASTM D 632 gradation) 32 degrees

Melting Point 800.8 degrees C (1473.4 degrees F)

Boiling Point 1465 degrees C (2669 degrees F)

Hardness (Moh's Scale) 2.5

Critical Humidity at 20 degrees C, (68 degrees F) 75.3%

pH of aqueous solution - neutral

Title: <u>Temperature of the Ocean Water</u>

(Water Chemistry)

<u>Grade Level (s)</u>: 6 - 8

<u>Introduction</u>: We all have experienced being inside the ocean and suddenly feeling that the water gets colder or warmer than usual. The ocean water has various temperatures in different regions because the rays of the sun, which warm the surface of the ocean, reach the various parts of the ocean with different intensity.

In this activity, learners will investigate the temperature changes in a column of cold ocean water, which will be exposed to a source of light. Learners will use a TI calculator and the CBL (Calculator Based Laboratory) in conjunction with three temperature probes.

<u>Learner Objectives</u>:

- Describe the heating of the ocean water by the sun or light source.
- Record and observe differential heating of the ocean water with depth.
- Determine a temperature-depth profile of the ocean by graphing the data obtained for temperature and depth.

<u>Florida Sunshine State Standards</u>: Science: SC.A.1.3.1, GLE 1, SC.A.2.3.3, GLE1, SC.B.1.3.5, GLE 1(grade 8), SC.B.2.3.1, GLE 1, SC.H.1.3.2, GLE 1, SC.H.1.3.5, GLE(s) 1,2,3; Math: MA.D.1.3.1, MA.D.1.3.2

<u>Competency-Based Curriculum</u>: Science: M/J1-I.1.A, I.2.A, I.3.A, I.8.A, I.1.B, 1.2.B, IV.1.A; M/J2-I.3.A, M/J2-I.8.B, I.1.B, 1.2.B; M/J3-I.3.A, I.8.A, I.1.B, I.2.B, III.2.A

Materials

1. TI Graphing calculator
2. 3 Vernier Temperature Probes
3. TI-Graph Link (optional)
4. Powdered dye
5. Ocean water
6. Ice
7. Lamp (if done in the lab)
8. Meter stick
9. Aquarium (10 gallon, if in the lab) OR 5 gallon plastic bucket (if on boat)

Activity Procedures:

1. Cool the water in the aquarium to about 4°C with ice. Do not go below this temperature. When the desired temperature is reached, remove the excess ice, and stir the water well. (While some members of the group are working on preparing the water tank, the others should be setting up the calculator, CBL, and probes, steps 2 to 7)
2. Plug the three temperature probes into the adapter cable in Channels 1,2, and 3 of the CBL System. Use the link cable to connect the CBL to the TI Graphing Calculator. Firmly press in the cable ends.
3. Place the tip of the three probes, one at the bottom, one in the middle, and the third one near the top of the aquarium.
4. Turn on the CBL unit and the calculator. Start the CHEMBIO program and proceed to the MAIN MENU.
5. Set up the calculator and CBL for three temperature probes.
    - Select SET UP PROBES from the MAIN MENU
    - Enter “3” as the number of probes
    - Select TEMPERATURE from the SELECT PROBE menu
    - Enter “1” as the channel number, and repeat the last two steps for channels 2 and 3
    - Select USE STORED from the CALIBRATION menu
6. Set up the calculator and CBL for data collection
    - Select COLLECT DATA from the MAIN MENU
    - Select TIME GRAPH from the DATA COLLECTION menu
    - Enter “15” as the time between samples, in seconds
    - Enter “90” and the number of samples (the CLB will collect data for a total of 22.5 minutes)
    - Press “Enter”. Select USE TIME SETUP to continue. If you want to change the sample time or sample number, select MODIFY SETUP
    - Enter “0” as the minimum temperature (Ymin)
    - Enter “25” as the maximum temperature (Ymax)
    - Enter “5” as the temperature increment (Yscl)

Activity Procedures (Con't.):

7. Using the meter stick, measure the distance where you need to place the three temperature probes in order to place one near the bottom, the second near the center of the water column, and the third one submerged near the top. Using rubber bands, secure the three temperature probes in their assigned spot on the meter stick. Submerge the meter stick with the three temperature probes.
8. If this experiment is done in the lab, a lamp should be set to reflect the light on the top of the tank, 30 cm directly above the center of the tank. At this point, you may turn on the lamp. In the field, the sun will take the place of the lamp.
9. Begin to monitor temperature by pressing "Enter." The temperature readings in °C, are displayed on the calculator in the form of a graph. The CBL will display one of the temperatures; the others can be seen by pressing the "Ch View" button.
10. When data collection stops, and "DONE" appears on the CBL screen, press "Enter" to display the graphs of temperature vs. time on the calculator screen. To confirm the temperature values, examine the data points along the curves, As you move the cursor right or left, the time (X) and temperature (Y) values of each data point are displayed below the graph. Determine the maximum temperature and the minimum temperature (round to the nearest 0.1 degree Centigrade). If graph link and computer are available, print the graph.
11. Record the lowest and highest temperature achieved at the levels on the data table.
12. Sprinkle a small amount of powdered dye over the water surface. Observe particularly the trails left by the sinking of the heavier particles.
13. Blow air gently over the water with the air flowing almost parallel to the water surface. Don't make waves. Periodically blow from the other direction. The aim is to mix the upper part of the water column until it is a uniform color.
14. Measure the lower limit of the dyed layer.
15. When you have finished with the model, carefully empty and clean the tank and equipment.

Data Table:

Section of Aquarium or Bucket	Depth (in cm)	Initial Temperature	Final Temperature
Top			
Center			
Bottom			

Observations:

1. When adding the dye (step 12):

___

___

___

2. When air is blown (step 13)

___

___

___

3. Measurement of the lower limit of the dyed layer (step 14)

___

___

___

4. Plot a graph of depth (y-axis) versus temperature (x-axis)

Student Assessment:

The students should prepare a lab report, which should include all major parts of a lab report plus the graph and the answers to the following questions:

1. Describe the appearance of your graph. What does it indicate? Explain.
2. What happens to the temperature as the depth increases?
3. Why do you think that the temperature changes differently at the different depths? What happens to the rays of the sun and the heat with depth?
4. Will the amount of salt in the water affect your results?

Activity Extensions:

1. Obtain lake water and try a similar experiment.
2. Compare your results and those of others obtained when samples from more than one source, with different salinity content, are tested.
3. Try using two TI/CBL systems and 6 temperature probes with one aquarium to obtain more accurate measurements of the different temperature in the thermocline.
4. Interdisciplinary: Search on the internet and write an essay on how the depth and temperatures of the oceans affect the life and the economy of certain cities in the world. (Language Arts, Technology, Social Studies)

Home Learning Activity:

Allow students to bring in samples of water from the ocean, lake, and surroundng areas to measure and compare in the classroom.

Vocabulary: temperature, thermocline

References/Related Links:

Holmquist, D.D., Randall, J., Volz, D.L., (1995) Chemistry with CBL, Portland, OR; Vernier Software

Sager, R.J., Ramsey, W.L.., Phillips. C.R., Watenpaugh, F.M., (1998) Modern Earth Science, Austin, TX; Holt, Rinehart and Winston

Temperatures of the Ocean Water

Reading Passage

We all have the experience of feeling changes in the water temperature at the beach when we are swimming or simply standing inside the water. However, if we go to deeper water, we may experience very cold waters. The ocean has the ability to absorb the heat from the sun, but this heat penetrates mostly on the top layer of the ocean. The ability of the sun's rays to penetrate deeper section of the ocean decreases as the depth of the ocean increases.

The top layer of the ocean, which is heated faster by the sun's ray, is called the surface zone. This zone is in contact with the atmosphere. It changes seasonally because of variations in precipitation, evaporation, cooling and heating. The surface zone contains the warmest (>10°C) and least dense (least heavy) waters in the ocean. (Average surface water temperature is 17.5°C) The surface zone is between 100 to 500 meters thick.

Because the sun cannot directly heat ocean water below the surface zone, the temperature of the water drops sharply as the depth increases. This zone of rapid temperature change is called the thermocline. The thermocline exists because the water near the surface becomes less dense (less heavy) as it is warmed by the heat. This warm water cannot mix easily with the cold, dense water below. Thus, a thermocline marks the distinct separation between the warm surface waters and the colder deep water. Changes in either temperaute or salinity (or both) can cause the marked change in density.

Below the thermocline, the temperature of the water continues to drop, but it does so very slowly, making the temperature of most deep ocean water just above freezing.

Temperature of the Ocean Water

FCAT Questions

Directions: Read the passage, then answer the questions below. Answer multiple-choice questions by circling the letter of the answer that you select. Write your answer to the “Read, Think, and Explain” question on the lines provided.

1. What is the thermocline
   A. The top part of the ocean
   B. The zone of rapid temperature change
   C. The bottom of the ocean
   D. The inclination of the ocean

Answer: B

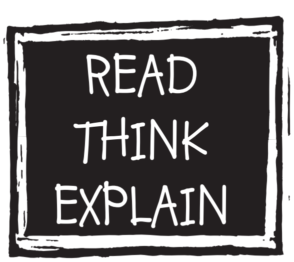
2. The thermocline exists because:
   A. Warm water mixes rapidly with cold wate
   B. Warm water does not mix with cold wate
   C. Warm water does not mix easily with cold water
   D. Warm water only mixes with hot water

Answer: C

3. How is the thermocline different from the surface zone
   A. The surface zone has warmer temperatures than the thermoclin
   B. The surface zone has colder temperatures than the thermocline
   C. The surface zone has the same temperatures as the thermocline
   D. The surface zone is three times as cold as the thermocline

Answer: A

4. Write a summary of the article. Include only the most important information on the text.



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Title: Density of Sea Water

(Water Chemistry)

Grade(s): 6-8

Introduction: Temperature and salinity affect the density of the water. Ocean salinity differs by small numbers, so oceanographers need to be accurate when measuring salinity. Changes in density caused by wind and currents at the surface affects the deep ocean currents. Density ultimately effects the objects that are existing in the water, such as whales, seaweed, and submarines. The saltier the water, the more buoyant an object becomes. Therefore, salt waters are constantly trying to find their "place" in the ocean according to their salinity. Very salty water is more dense, and will sink more, thus very salty water is found at the bottom. Less salty water is less dense and will float on top of the more dense salty water.

Of course the layers are more complicated than this, but for this activity, students should be able to understand that salt or fresh water drops are going to want to "hang out" in water with similar properties. So fresh water drops will rise to the fresh water layer and salt water drops will sink to the salt water layer. The salinity of the water mixes, or changes, only when vigorously stirred. Though students learn early on that the ocean contains salt water, it still does not mean that all water has the same amount of dissolved salt. The Navy, for example, pays close attention to salinity to be sure that they know how submarines will travel as they move through the different waters of the world.

Learner Objective(s):

- The student will observe how different water densities control the depth at which different water masses occur.
- The student will be able to understand how salinity affects the density of water.

Florida Sunshine State Standards: Science: SC.A.1.3.1 Math: MA.B.3.5.1/MA.B.2.3.1

Competency Based Curriculum: Science-M/J-III-1-A Math: M/J-1-III-2-A, Math-M/J-3-II-9-B

<u>Materials</u>:

1 large clear bowl (plastic, Pyrex, glass)
Clear tap water
Tap water dyed with blue food coloring
Clear very salty water
Slightly salty water dyed with red food coloring
Very salty water dyed with green food coloring
Four cups
Stirring rodTwo medicine droppers

<u>Activity Procedures</u>:

*The teacher may want to have the five types of water pre-made in labeled containers so students can easily locate them.

1. Label one cup “tap water” and fill it 3/4 full of *clear tap water*.
2. Fill one medicine dropper with *very salty green water*.
3. Place one drop of *blue tap water* into the cup with clear water.
4. Record observations.
5. Label one cup *“salty water”* and fill it 3/4 full with clear salt water.
6. Fill the other medicine dropper with blue tap water.
7. Place one drop of blue tap water into the cup with clear salt water.
8. Record observations.
9. Fill the clear bowl half full with very salty salt green water.
10. Pour clear tap water slowly into 1/4 of the bowl on top of very salty green water.
11. Record observations.
12. Making sure that the dropper is clean, fill the dropper with *slightly salty red water*.
13. Place the dropper into the layer of very salty green water and squeeze out a drop of slightly salty red water.
14. Record observations.
15. Take the same dropper of slightly salty red water and place it into the layer of clear tap water and squeeze out a drop of slightly salty red water.
16. Record observations.
17. Using the stirring rod, mix the layered water system together.
18. Record observations.

Student Assessment:

Allow student to answer critical thinking skills questions assigned by the teacher.

a How can you apply this knowledge to the open ocean and to the Navy's uses of submarine buoyancy?

b. If you pack more mass into the same volume, is it more dense?

c. If you pack the same mass into a smaller volume, is it more dense?

d. Just because something has more mass, does it mean it is more dense?

Have students report observations from steps #4, #8, #11, #14, and #16 from the Activities Procedures.

Activity Extension(s):

Measure the density of various objects with the use of a scale and a graduated cylinder (Math).

The water chemistry of the Pacific Ocean is different from that of the Atlantic Ocean.Water temperature, salinity, and density are among those factors. Research these factors(Social Studies).

Assume that you are an underwater scuba diver. Write a fictitious letter to a friend describing the changes that you experience as you swim deeper into the water (Language Arts).

Home Learning Activity:

Explain the effect of temperature and salinity on the density of water.

Vocabulary: temperature, salinity, density, buoyant

References/Related Links:

www.educationworld.com

http://www.uscgboating.org

http://www.odysseyexpeditions.org/oceanography.html

www.aquanet.com

Density of Sea Water

Reading Passage

The proportionality constant between mass and volume is called the density of the substance. Density is a physical property that is measured in derived units and it is defined as mass per unit volume. It is a ratio of mass over volume (D=M/V). Seawater, for instance, is a homogenous mixture made up of various solutes including sodium chloride dissolved within the pure water solvent. Seawater is heavier than pure water, thus it is termed denser. Density is linearly related to the mass of the substance and inversely related to the volume of the substance. Temperature and salinity play key roles in the density of seawater.

The temperature of surface ocean water ranges from 26C degrees (79F degrees) in tropical waters to -1.4C degrees (29.5F degrees), the freezing point of seawater, in polar regions. Surface temperatures generally decrease with increasing latitude, with seasonal variations far less extreme than on land. In the upper 100 m (330 ft) of the sea, the water is almost as warm as at the surface. From 100 m to approximately 1000m (3300 ft), the temperature drops rapidly to about 5C degrees (41F degrees), and below this it drops gradually about another 4 degrees to barely above freezing. The region of rapid change is known as the thermocline. The colder the water becomes, the denser it becomes. The warmer the water becomes, its density drops. There is a linear relationship between temperature and volume (Charles Gas Law), thus causing an inverse effect with the density of the substance. In other words, an increase in temperature will cause an increase in volume and therefore will cause a decrease in its density, and vice versa.

The molecular weight of sodium chloride is 58; heavier than that of water (18). The density of sodium chloride is 2.165, exceeding that of water. Salinity of seawater increases the density of seawater because it has a linear effect with its mass. Salinity increases the mass thereby increasing the density, and vice versa. The amount of sodium chloride present in seawater adds to the already existing amount of solubles dissolving within the water solvent. The saltier water tends to sink to the bottom surface of the ocean and the less saltier water tends to remain above the saltier water. This occurs as a result of the density of seawater.

Density of Sea Water

FCAT Questions

Directions: Read the passage, then answer all the questions below. Answer multiple-choice questions by circling the letter of the answer that you select. Write your answer to the “Read, Think, and Explain” question on the lines provided.

1. Very salty water is more dense and will:
   - A. Sink more
   - B. Float more
   - C. Stay constant throughout the water
   - D. Multiply

   Answer: A

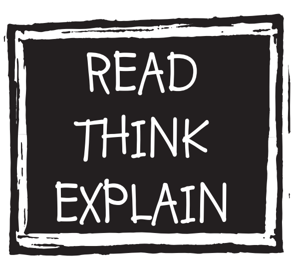
2. Which of the following does not affect the density of water?
   - A. Temperature
   - B. Mass
   - C. Salinity
   - D. Pressure

   Answer: D

3. Which of the following does not cause changes in density?
   - A. Temperature
   - B. Sea life
   - C. Currents
   - D. Altitude

   Answer: D

4. Explain why the Navy needs to understand the importance of water density?



Title: Ten Fathoms Under the Sea

(Water Pressure)

Grade Level(s): 6-8

Introduction: Pressure is defined as the force per unit area exerted upon an object. Changes in pressure lead to the development of winds, which in turn influence our daily weather. Water pressure changes with depth due to the amount of force being exerted. The amount of time that a diver can remain under water depends largely on water pressure. As a diver descends the surrounding water pressure increases causing a slight discomfort in their ears and sinuses. Divers relieve this discomfort through equalizing by holding their noses and blowing gently, or swallowing. Decompression sickness, also called the bends, is an injury that occurs if a diver ascends too quickly or dives too deeply for too long.

Learner Objectives:

- Students will determine how water pressure differs at various depths by observing water flow.
- Students will determine how scuba diving and lung capacity is affected by changes in water pressure.

Sunshine State Standards: Science: SC.C.2.3.3.1, SC.D.1.3.3 Math: MA.E.1.3.1, MA.E.1.3.3.

Competency-Based Curriculum: Science: Sci.M/J3 III-1-A ; Math: M/J1 V-2-A , Math.M/J3 VI-7-A

Materials:

tin cans
container of water with small cup
masking tape
shallow basin to collect water
paper towels
lab worksheet.

Activity Procedures:

1. Divide the class into groups of four and assign each student one of the following roles. Each group needs to have all of the materials listed.

   A. Materials- to collect and maintain materials needed for lab.
   B. Recorder- to record information from the lab on the Worksheet.
   C. Technician- to perform manipulation of the lab work
   D. Maintenance- to clean up the lab station and be prepared for any mishaps(spills).

2. The group should form a hypothesis for the results and the recorder should record these on the Lab Worksheet.
3. Place the tin can in a shallow basin with the holes plugged by masking tape.
4. Fill the can with enough water to cover each hole. Make sure that no water is leaking from the tape.
5. While holding the can with one hand, the technician removes the tape. Observe and record.
6. Which hole has the stronger stream? Which hole has the weaker stream? Why?

Student Assessment:

Ask one student from each group to share lab results and discuss the results that each individual group discovered. Develop rubrics for assessing student work.

Activity Extensions:

Encourage interested students to contact a local diving shop or certified diving instructor to find out how the special equipment worn by deep-sea divers controls pressure. (Science, Physical Education)

Home Learning Activity:

Have students write and illustrate a story describing the changes in fluid pressure experienced by a diver as he/she rises from the ocean floor to the surface.

Vocabulary: Pressure, decompression sickness, equalization

References/Related Links:

http://encarta.msn.com/index/conciseindex

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/fw/home.rxml

www.aquanet.com

http://www.mtsinai.org/pulmonary/books/scuba

Ten Fathoms Under the Sea

Reading Passage

Water pressure, like air pressure is a function of weight; the deeper one goes the greater the surrounding water pressure. The marked increase in water pressure with depth affects every scuba and non scuba diver. Water is not compressible and unlike air it does not become denser as pressure increases. One cubic foot of water at 130 feet depth has the same weight and density as a cubic foot of water at 33 feet. Sea water pressure changes one whole atmosphere every 33 feet. A column of sea water 33 feet high weighs the same as a column of the earth's entire atmosphere.

The human body under water can be viewed as made up of two groups of organs that differ in how they respond to water pressure. One group of organs is compressible by the water pressure, and the other group is non-compressible. Bone, muscle, blood, and organs such as kidneys, the heart, and the liver are all non compressible and therefore, unaffected by water pressure. These organs and tissues have the same (or higher) density than water and can withstand intense water pressure without any problem. The compressible areas contain some air and include the lungs, middle ears, sinuses, nasal passages, and interior of hollow organs.

Breath-hold diving is still employed for both recreation and commerce. It requires special skills beyond the ability to hold one's breath, such as withstanding the squeeze of descent and quickly accomplishing a goal when the desired depth is reached. Scuba requires none of these skills. For most people, scuba is much easier to master than breath-hold diving. Through the development of scuba diving, it is possible for just about anyone with healthy lungs and heart to stay under water for long periods. Compressed air diving presents two problems that breath-hold divers do not have to worry about: decompression sickness and air embolism.

Ten Fathoms Under the Sea

FCAT Questions

Directions: Read the passage, then answer the questions. Answer multiple choice questions by circling the letter of the answer that you select. Write your answer to the "Read, Think, and Explain" question on the lines provided.

1. One atmosphere is equivalent to how many feet of sea water?

   A. One cubic foot
   B. 33 feet
   C. 130 feet
   D. 600 feet

Answer: B

2. An increase in water depth causes an increase in which of the following?

   A. Water pressure
   B. Water density
   C. Weight of water
   D. Organ non-compressibility

Answer: A

3. Which one of the following organs is considered to be a compressible area?

   A. Bone
   B. Kidneys
   C. Lungs
   D. Heart

Answer: C

4. Compare and contrast breath-hold diving and scuba diving.