The NASA SCI Files™

The Case of the Ocean Odyssey

Segment 2

While continuing to prepare for his underwater treasure hunting adventure at the Jules Underwater Hotel, Tony appears to be having more incidents of irritation (IOI). Meanwhile, after learning that differences in the ocean's salinity can cause currents, the other detectives decide that they need to learn more about density currents. They dial-up Dr. Chris Martens, professor at the University of North Carolina, who is in Key Largo, Florida completing a research project. Dr. Martens has just surfaced from the Aquarius, an underwater research laboratory operated by the National Oceanic and Atmospheric Administration (NOAA) and NASA. Dr. Martens helps the detectives understand density currents and upwellings. While in the tree house, the detectives also listen to Dr. Textbook as he talks about the Gulf Stream. Curious to learn more about surface currents, the detectives head to NASA Goddard Space Flight Center in Maryland to meet Dr. David Adamec. Thinking that surface currents have to be the answer, the detectives meet Dr. D at the Hubba Hubba Highway in Water Country USA, Williamsburg, Virginia, where he demonstrates how to find the velocity of a moving stream of water. Catherine and RJ are really surprised to find that they are both weak swimmers when they try to swim against a fast-moving current!

Objectives

Students will

- understand density currents and upwellings.
- understand the challenges of living in an underwater habitat.
- learn the path and importance of the Gulf Stream.
- understand how surface currents form.
- calculate the speed of a moving object.

Vocabulary

climate—the average of all weather conditions in an area over a long period of time

Coriolis effect—the effect of Earth's rotation on the movement of air masses

density current—an ocean current that occurs when denser seawater moves toward an area of less dense seawater

global conveyor belt—a term used to express the idea of ocean-based elements of the climate system that transport heat; see also thermohaline circulation

Gulf Stream—an ocean current that flows out of the Gulf of Mexico, then northward along the East Coast of the US, and then toward Europe

surface current—an ocean current found in the upper few hundred meters of seawater

thermocline—the transitional layer of water between two layers that are relatively uniform in temperature: the mixed layer at the surface and the much colder deep water layer

thermohaline circulation—global ocean circulation driven by differences in the density of the seawater, which is controlled by temperature (thermo) and salinity (haline)

topography—the features on the surface of a particular area of land

velocity—the speed of an object in one direction

water cycle—the path water takes as a liquid, solid, or gas as it moves throughout Earth's systems; also known as the hydrological cycle

upwelling—the rising of deeper colder water to shallower depths

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 2 of *The Case of the Ocean Odyssey*, discuss the previous segment to review the problem and reaffirm what the tree house detectives have learned thus far. Download a copy of the **Problem Board** from the NASA SCI Files™ web site, select **Educators**, and click on the **Tools** section. The **Problem Board** can also be found in the **Problem-Solving Tools** section of the latest online investigation. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 1 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 1. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Review the list of ideas and additional questions that were created after viewing Segment 1.
5. Read the Overview for Segment 2 and have students add any questions to their lists that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.
7. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. They can be printed from the web site ahead of time for students to copy into their science journals.

View Segment 2 of the Video

For optimal educational benefit, view *The Case of the Ocean Odyssey* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about oceans, tides, and currents.
4. Organize the information and determine whether any of the students' questions from the previous segments were answered.
5. Decide what additional information is needed for the tree house detectives to determine what has caused the tennis shoes and oil globs to wash up on the beach. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
6. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.

Careers

marine biologist
ocean engineer
physical oceanographer
marine policy specialist
diver
cartographer

7. For related activities from previous programs, download the **Educator Guide**. On the NASA SCI Files ™ home page, select **Educators**. Click on **Episodes** in the menu bar at the top. Scroll down to the 2003–2004 Season and click on *The Case of the Wacky Water Cycle*. In the green box, click on **Download the Educator Guide**.

   a. In the **Educator Guide** you will find

   a. **Segment 2** – *Just an Ocean Away*

   b. **Segment 3** – *Going Up, Going Down*

   Close the PDF window and return to the **Educators Activities** page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Mysterious Red Light*. In the green box, click on **Download the Educator Guide**.

   a. In the **Educator Guide** you will find

   a. **Segment 4** – *Global Winds*

   b. **Segment 4** – *How Fast Does She Blow?*

   Close the PDF window and return to the **Educator Guide** page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Inhabitable Habitat*. In the green box, click on Download the Educator Guide.

   a. In the **Educator Guide** you will find

   a. **Segment 3** – *Float or Sink: Neutral Buoyancy*

   Close the PDF window to return to the **Educator Guide** page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Phenomenal Weather*. In the green box, click on **Activities/Worksheets**.

   b. On the web site in the **Activities/Worksheets** section, you will find

   a. *Round and Round We Go*

   b. *Catchin' a Breeze*

7. If time did not permit you to begin the web activity at the conclusion of Segment 1, refer to number 6 under **After Viewing** on page 15 and begin the Problem-Based Learning activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, Problem-Based Learning activity:

   Research Rack—books, Internet sites, and research tools

   Problem-Solving Tools—tools and strategies to help guide the problem-solving process

   Dr. D's Lab—interactive activities and simulations

   Media Zone—interviews with experts from this segment

   Expert's Corner—listing of Ask-An-Expert sites and biographies of experts featured in the broadcast

8. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the **PBL Facilitator Prompting Questions** instructional tool found by selecting **Educators** on the web site.
9. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. For more assessment ideas and tools, go to **Educators** and click on **Instructional Tools** in the menu bar.

Resources *(additional resources located on web site)*

Books

Bankston, John: *Jacques-Yves Cousteau: His Story Under the Sea*. Mitchell Lane Publishers, Inc., 2002, ISBN: 1584151129.

Barber, Jacqueline: *Discovering Density*. University of California Berkeley, Lawrence Hall of Science, 2001, ISBN: 0924886617.

Castaldo, Nancy: *Oceans: An Activity Guide for Ages 6–9*. Chicago Review Press, 2002, ISBN: 1556524439.

Earle, Sylvia: *Dive*. National Geographic Society, 1999, ISBN: 0792271440.

Ganeri, Anita: *I Wonder Why the Sea Is Salty and Other Questions about the Ocean*. Houghton Mifflin, 2003, ISBN: 0753456117.

Greenburg, J.C.: *Under Water*. Random House Books for Young Readers, 2003, ISBN: 0375825231.

Helligman, Deborah: *The Mysterious Ocean Highway*. Steck-Vaughn, 1999, ISBN: 0739812270.

Kovacs, Deborah: *Dive to the Deep Ocean: Voyages of Exploration and Discovery*. Steck-Vaughn, 1999, ISBN: 0739812351.

Nye, Bill: *Bill Nye the Science Guy's Big Blue Ocean*. Hyperion Books for Children, 2003, ISBN: 0786817577.

Video

Children's Video Encyclopedia: Water and Weather, Vol. 2
Grades 4–8

Discovery Channel: Raging Planet: Tidal Wave
Grades 6–12

Disney Channel: Buoyancy (Bill Nye the Science Guy)
Grades 3–6

Disney Channel: Oceanography (Bill Nye the Science Guy)
Grades 3–6

DK Publications: Eyewitness Video: Seashore
Grades 4–8

NASA: Planet Earth – Oceania
Grades 3–adult

Web Sites

NASA Oceanography
As part of NASA's Earth Science Enterprise (ESE), NASA Oceanography contributes to our understanding of planet Earth as a system in both behavior and evolution. ESE's mission is to develop an understanding of the total Earth system and the effects of natural and human-induced changes on the global environment.
http://oceans.nasa.gov/Home.htm

NASA: Ocean Surface Topography from Space
Visit this site to learn how NASA studies the oceans from space. See the current missions and check out some cool stuff for kids.
http://topex-www.jpl.nasa.gov/index.html

NASA: Oceanography
Spend some time checking out this interesting web site. Learn about the various missions, view some awesome images of the oceans and Earth from space, and much more. *http://oceans.nasa.gov/Home.htm*

NOAA's Aquarius: America's Innerspace Station
Aquarius is an underwater ocean laboratory located in the Florida Keys National Marine Sanctuary. The laboratory is deployed three and a half miles offshore, next to spectacular coral reefs at a depth of 60 feet. Scientists live in Aquarius during 10-day missions and perform saturation diving to study and explore our coastal ocean waters. *http://www.uncw.edu/aquarius/*

Florida Keys National Marine Sanctuary
This marine sanctuary provides a safe habitat for species close to extinction and protects historically significant shipwrecks. *http://www.fknms.nos.noaa.gov/*

NOAA's Undersea Research Center
This web site gives information about the Undersea Research Center at the University of North Carolina at Wilmington. You can see live web cams, learn about the ongoing research at the Undersea Research Center, and learn about some of the technology used at the Center that supports Aquarius, the world's only underwater habitat. *http://www.uncw.edu/nurc/*

Windows to the Universe: Currents of the Ocean
This fantastic web site presents information about different types of currents and the major ocean currents. Three levels are offered for the beginner, intermediate, and advanced learner. Also find some great teacher resources and activities. This site is also available in Spanish.
http://www.windows.ucar.edu/tour/link=/earth/Water ocean_currents.html&edu=elem

Brain POP: Currents
This interactive web site uses comics, movies, and activities to teach kids facts about currents.
http://www.brainpop.com/science/earth/oceancurrents/index.weml

The Gulf Stream
Visit this site to learn about the Gulf Stream. Discover historical facts about the Gulf Stream, its climate and weather influence, and the observational tools used for research. See satellite observations and learn about the Gulf Stream's influence on ocean going vessels.
http://fermi.jhuapl.edu/student/phillips/

Benjamin Franklin and the Gulf Stream
Learn the facts about exploration of the Gulf Stream and the role that Benjamin Franklin played in publishing its whereabouts.
http://www.oceansonline.com/ben_franklin.htm

University of Illinois at Urbana-Champaign: Coriolis Effect
This great web site gives more information about the Coriolis effect and has an informative video clip.
http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/fw/crls.rxml

NASA Goddard Space Flight Center
Located in Maryland, NASA Goddard Space Flight Center is home to the Nation's largest organization of combined scientists and engineers dedicated to learning and sharing their knowledge of the Earth, solar system, and Universe.
http://www.gsfc.nasa.gov/

Ocean Surface Currents
This interactive web site teaches visitors about the major ocean surface currents. Maps show the surface currents, including their direction and temperature.
http://oceancurrents.rsmas.miami.edu/

University of Illinois: Upwelling
Visit this web site to learn more about upwellings and how they bring nutrient rich water from deeper levels to replace the surface water that has drifted away. Learn also how upwelling affects El Niño.
http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/eln/upw.rxml

Great Ocean Conveyor Belt
Visit this site for a map of thermohaline circulation and learn how it can change climates over the years.
http://www.grida.no/climate/vital/32.htm

Activities and Worksheets

In the Guide

On the Web

Sealz, Salz, Saldus, Sal, Hals, and More NaCl

Segment 2

Purpose

To understand that ocean water is salty

To learn the purpose and use of a hydrometer

Materials

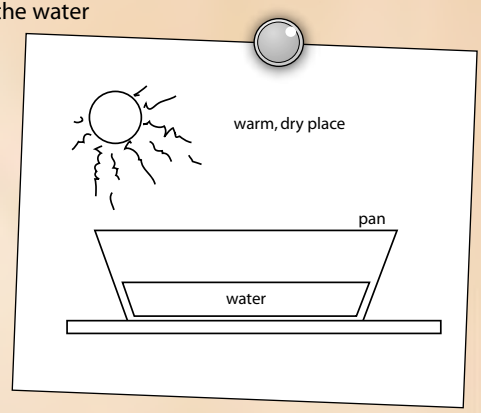
pie pan
water
table salt
1,000 red and blue construction paper dots
balance
large cup (1000 mL)
1000 mL graduated cylinders
plastic spoons
large jar
modeling clay
metric measuring spoon
cap from a pen
metric ruler
Ocean Salt Chart (p. 36)
science journal

Background

The ocean covers over 70% of the Earth's surface. The ocean is one large body of water, divided into 5 major bodies of water based on ocean current flow: the Atlantic, Pacific, Indian, Arctic, and Southern Oceans. Ocean water is approximately 96% pure water and 4% dissolved elements. The two most abundant dissolved elements in ocean water are sodium (Na) and chlorine (Cl). Sodium plus chlorine form sodium chloride, or common salt.

If you have ever gone swimming in the ocean, you know that the water is salty. The term salinity describes the amount of dissolved salt in the ocean. Salinity is expressed in parts per thousand. The salinity of the ocean can vary from 33 to 37 parts per 1000, although the average salinity is 35 parts per 1000. In other words, for every 1000 parts of ocean water, 35 of them (3.5%) are salt. Concentrations of salt may vary because of depth, temperature, location, and many other factors. Tropical and some polar waters tend to have higher salinity levels. Waters close to freshwater rivers tend to have lower salinity levels. Surface water salinity varies greatly due to evaporation, precipitation, and runoff from the land. Deeper water does not have such a variance in salinity.

River runoff carries salt into the ocean. Rivers wash mineral material from the land into the ocean. Volcanic activity on land and in the ocean also contributes to the salinity of ocean water. Scientists use a tool called a hydrometer to measure how dense the water is. Salt makes water more dense.



Teacher/Adult Note

Have the red and blue paper holes (dots) already punched. Put both colors in a container for the students to use. Each group should have 1,000 red and blue dots (any combination, but more blue than red).

Because the students have the option to taste the saltwater mixture, make sure that all materials are clean and sanitary.

After viewing Segment 2, review with the students Dr. D's explanation about where the salt comes from and how it gets into the oceans.

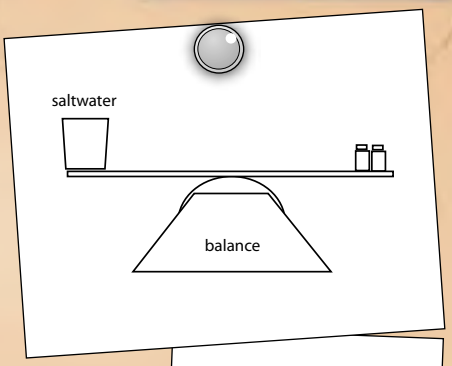
Procedure A: Ocean Water

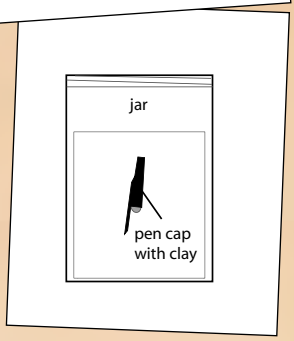
1. To simulate ocean water, measure 480 mL of water and pour it into pie pan.
2. Measure 10 mL of salt and sprinkle over the water.
3. Use a plastic spoon to stir and mix the salt and water thoroughly.
4. Place the pan in a warm, dry place.
5. Observe the water in the pan. Record your observations in your science journal.
6. Use a metric ruler to measure the depth of the water and record it.
7. Allow the water to evaporate (evaporation may take a few days).
8. Observe and measure the water at the same time each day and record your observations in your science journal.

Sealz, Salz, Saldus, Sal, Hals, and More NaCl

Segment 2

Procedure B: Parts Per Thousand





1. To simulate saltwater, count 1,000 red and blue dots from the dot container. You should have more blue dots than red.
2. Separate the red and blue dots. Count and record the number of red dots in the Ocean Salt Chart (p. 36).
3. To find the number of blue dots, subtract the number of red dots from 1,000. Record the number in the Ocean Salt Chart.
4. On the Ocean Salt Chart, write the salinity (parts per thousand) of your simulated ocean water by writing the number of red dots and adding "ppt" (parts per thousand) after the number. Note: The average ocean salinity is 35 ppt. How does your simulated ocean water compare?
5. On the Ocean Water Chart, create a graph that shows the salinity of your simulated paper dot saltwater. Be sure to label the axis, title the graph, and create a key.

   NOTE: *A gram of water at 4º C is equal to 1 mL. To simplify this exercise, 1 gram of water is equal to 1 mL. However, when 35 mL of salt is added to the water, it will not increase the volume to 1,000 mL because the sodium and chloride ions occupy space between the water molecules.*
6. Oceanographers use grams to determine the mass (weight) of ocean water, so for every 1,000 grams of ocean water, on average, 35 grams would be salt.
7. Using a balance, find the mass of the paper cup.
8. To find the total amount of salt needed, add the mass of the paper cup to 35 g and record.
9. Place the cup on the balance and add salt until you reach the total mass required.
10. To find the total amount of water needed, subtract 35 from 1,000 and record.
11. Using 1 g = 1 mL, add the correct number of mL (of water) to the graduated cylinder.
12. Pour the measured salt into the graduated cylinder.
13. Using a spoon, gently stir until well mixed. No salt should remain on the bottom.
14. Using the spoon, taste the saltwater mixture and record your observations.
15. Have your group discuss how the salty water tasted. Was it really salty or not very? If you or another group member has swum in the ocean, compare the saltiness to the ocean water you swam in.

Procedure C: Hydrometer

1. Oceanographers use instruments called hydrometers to measure the salinity of water.
2. To make a hydrometer, first fill the jar three-fourths full of water.
3. Place modeling clay into the pen cap so that the cap will sink about halfway when placed in the jar of water. This task may take some practice.
4. Measure 15 mL of salt and add it to the water.
5. Stir with a spoon until all salt is dissolved.
6. Place the pen cap into the jar of saltwater and observe.
7. Use a metric ruler to estimate the depth at which the cap is floating.
8. Record your observations in your science journal..
9. Repeat steps 4–8.
10. Repeat steps 4–8, continuing to add 15 mL of salt at a time until you have added 75 mL of salt to the water.

Sealz, Salz, Saldus, Sal, Hals, and More NaCl

Ocean Salt Chart

Conclusion

1. What happened when all the water evaporated from the pie pan? Was there anything left in the pie pan? Why or why not?
2. What does ppt mean? What is the average salinity of ocean water?
3. Is saltwater heavier than freshwater? Explain.
4. Why doesn't all ocean water have the same salinity level?
5. What happened to the pen cap as more salt was added to the water? Why?
6. What could an oceanographer use a hydrometer for?
7. Why did the tree house detectives need to learn about salinity?

Extension

1. Tropical waters tend to have a higher salinity level than other ocean water. Using the Internet, research to find where the tropical waters on Earth are located. On a blank world map, shade in the areas of tropical waters with one color. Use a different color to shade the other ocean areas that have cooler waters.
2. Research to find the salinity of the Great Salt Lake in Utah, the Dead Sea between Israel and Jordan, the Caspian Sea in Asia, and the Aral Sea in Asia. Determine whether the salinity of each body of water is higher or lower than the average ocean salinity (35 ppt). Hypothesize and explain why or why not.

Dense and Denser

Segment 2

Purpose

To understand density

Background

Density currents are currents of varying masses. A current of lesser mass will float on top of a current of greater mass. There are several factors that cause currents to vary in mass. Two are temperature and salinity. Warm-water currents will float on top of cold-water currents because cold water is denser than warm water. Likewise, freshwater currents will float on top of saltwater currents because saltwater is denser than freshwater.

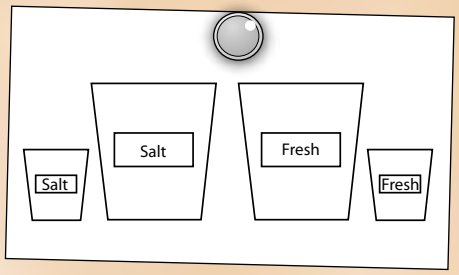
Teacher Note: Remember that density is defined as mass per unit volume:
$D = M/V$

Materials

salt
water
green and blue food coloring
2 eyedroppers
2 small, clear cups
2 large, clear cups
graduated cylinder
science journal
measuring spoons
masking tape
pen

Procedure

1. With masking tape, label one large and one small cup "Saltwater."
2. Label the other large and small cup "Freshwater."
3. Use the graduated beaker to measure 200 mL of water and pour it into the large "Saltwater" cup.
4. Repeat step 3 for the large "Freshwater" cup.
5. Using a measuring spoon, measure 15 mL of salt and pour it into the large "Saltwater" cup. Stir until all salt is dissolved.
6. Use the graduated cylinder to measure 30 mL of saltwater from the large "Saltwater" cup and pour it into the small "Saltwater" cup.
7. Repeat step 6 for the freshwater.
8. Add 3–5 drops of green food coloring into the small "Saltwater" cup.
9. Add 3–5 drops of yellow food coloring to the small "Freshwater" cup.
10. Using what the tree house detectives learned from Dr. D and Dr. Martens, predict what will happen when you add saltwater to freshwater. Record your prediction in your science journal.
11. Predict what will happen when you add freshwater to saltwater and record.
12. Using an eyedropper, add several drops of green saltwater to the large "Freshwater" cup. Observe and record what happens.
13. Using a different eyedropper, add several drops of blue freshwater to the large "Saltwater" cup. Observe and record.
14. Discuss in your group your predictions and observations.



Conclusion

1. Explain what happened to the green saltwater when you added it to the freshwater?
2. Explain what happened to the blue freshwater when you added it to the saltwater?
3. What do you think happens when freshwater from rivers and runoff flows into the ocean?
4. In your own words, explain how this experiment shows density.

Extension

1. Repeat the experiment, adding more or less salt to create the saltwater cup. Add the saltwater to the freshwater cup and compare.
2. Brackish water is a mixture of freshwater and saltwater. Some animals and plants can live only in freshwater. Others can live only in saltwater. Do some research to find out which plants and animals can live in brackish water.

Going Up or Going Down?

Segment 2

Purpose

To understand how temperature affects the density of water

Note: *This activity may create water spills and should be conducted in an area that can get wet, such as over a sink.*

Materials

2 identical wide-mouth jars
warm water
cold water
blue food coloring
yellow food coloring
stir stick
stiff cardboard
tape
pen
science journal

Procedure

1. Using tape and a pen, label one of the jars "Warm" and the other jar "Cold."
2. Being careful, fill the "Warm" water jar with warm water.
3. Add 2–3 drops of blue food coloring and stir.
4. Fill the "Cold" water jar with cold water.
5. Add 2–3 drops of yellow food coloring and stir.
6. Place a piece of stiff cardboard that is larger than the mouth of the jars on top of the "Warm" water jar.
7. Carefully hold the cardboard tight to the rim of the jar and invert the jar. See diagram 1.
8. Carefully place the cardboard with the jar on top of the "Cold" water jar. See diagram 2.
9. Observe and record your observations.
10. Predict what will happen when the cardboard is removed from the warm water jar. From the cold water jar.
11. Carefully remove the cardboard and observe.
12. In your science journal, record your observations.

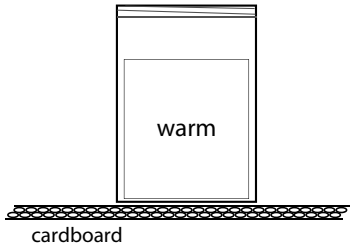


Diagram 1

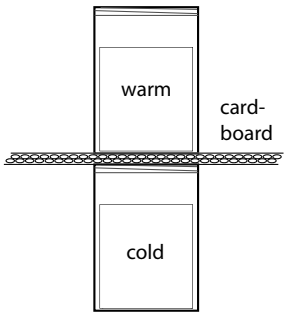


Diagram 2

Conclusion

1. What happened to the warm water? Why?
2. What happened to the cold water? Why?
3. Use what you learned from this experiment and from Dr. Martens (in the show) to explain how temperature causes density currents to form.

Getting Windy

Segment 2

Purpose

To create and understand surface currents

Background

Primarily, wind causes ocean surface currents. When winds blow for a long time, they can cause water to flow. Many factors affect wind-created ocean currents: the Earth's rotation, the seafloor topography, and land masses. Ocean currents affect life in the ocean, the climate of coastal land, and shipping routes. In this activity, you will see an example of a surface current and how landmasses affect it.

Materials

clear, shallow, glass pan
food coloring
small bowl
petri dish
variety of waterproof, irregularly shaped objects
science journal
water

Procedure

1. Fill the glass pan one-half full of water.
2. Add a drop of food coloring in one corner of the pan.
3. Gently blow across the water. See diagram 1.
4. Observe the surface of the water and the drop of food coloring as you blow on the water.
5. Record your observations in your science journal.
6. To create an island in your pan of water, place the small bowl upside down in the center of the pan so that the bottom of the bowl is sticking above the water. You may have to remove some water, depending on the size of your bowl. See diagram 2.
7. Add a drop of food coloring in front of the island.
8. Gently blow across the water.
9. Observe what happens to the surface of the water and the drop of food coloring around the island as you blow.
10. Record your observations.
11. Remove the bowl.
12. To create a seamount, place the petri dish upside down in the center of the glass pan. The petri dish should be completely submerged. See diagram 3.
13. Add a drop of food coloring in between the petri dish and you.
14. Gently blow across the water.
15. Observe what happens to the surface of the water and the drop of food coloring as you blow.
16. Record your observations.
17. Repeat steps 12–16 using irregularly shaped objects.

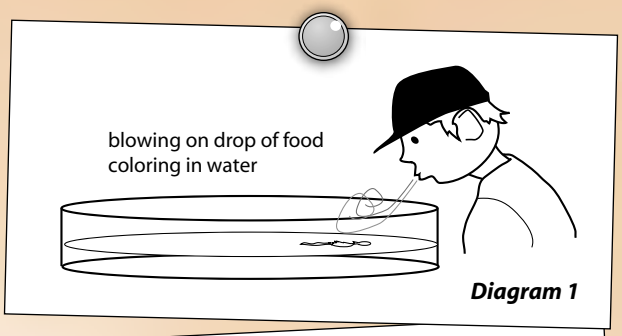


Diagram 1

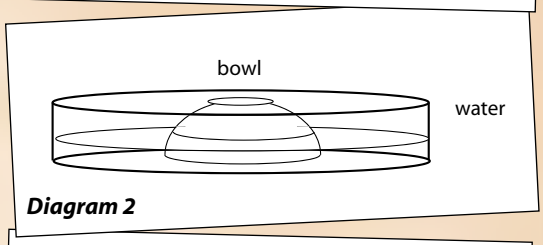


Diagram 2

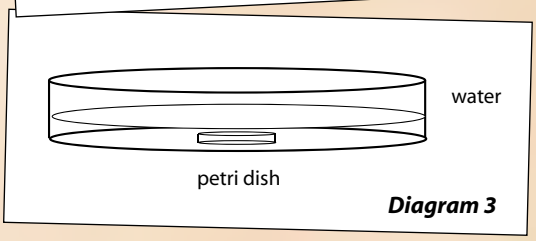


Diagram 3

Getting Windy

Segment 2

Conclusion

1. Where do the currents move most rapidly?
2. What happens to the water as it moves away from the wind source?
3. What affect did the island have on the current? Was the current stronger in front of the island or behind it? How can you tell?
4. How did the current around the petri dish differ from the one around the island?
5. How do the currents change around irregular shapes?
6. Do the currents always move in the direction of the wind? Why or why not?

Extension

1. Research to find a map of global surface currents. Make a map of the surface currents in the ocean nearest you.
2. Repeat the experiment, but this time when you blow across the pan's surface water, use a plastic straw. Were there any differences in your observations? Why or why not?

Doin' the Wave

Segment 2

Purpose

To calculate wave velocity

Background

Velocity is the rate at which an object changes position. Velocity depends on time and distance. To calculate velocity, you must know the distance in one direction an object has traveled and the time it took for the object to go that distance. The equation for velocity is velocity = distance divided by time (v = d/t).

In an ocean, waves are created by wind, but there is another kind of wave—a human wave. At many sporting events, people create human waves by waving their arms up and down in a successive motion that creates a wave across the stadium. In this activity, you will calculate the velocity of waves created by doing the human wave.

Materials

6 students
stopwatch
several people
meter stick
masking tape
activity sheet

Procedure

1. Measure and place 3 meters (m) of masking tape on the floor.
2. Label one end of the masking tape "A" and the other end "D."
3. Using a meter stick, measure 1 m from point A and label it "B."
4. Using a meter stick, measure 2 m from point A and label it "C." See diagram 1.
5. Have someone stand at each of the four points—A, B, C, and D.
6. The other two people will be either the timekeeper or the recorder.
7. The student standing at point A will begin the wave. Slowly raise both your hands in the air over your head and then back down again.
8. As the student at point A begins to lower his/her hands, the person at point B should begin step 7. See diagram 2.
9. Repeat steps 7 and 8 with students at points C and D.
10. The timekeeper starts the stopwatch as soon as the point A student begins and stops as soon as the Point D student lowers his/her arms.
11. The recorder records the time for trial 1 in the Wave Velocity Chart (p. 42).
12. Repeat steps 7–11 for 4 more trials.
13. Using the equation in the Wave Velocity Chart, determine the velocity for each trial.
14. Find the average velocity.

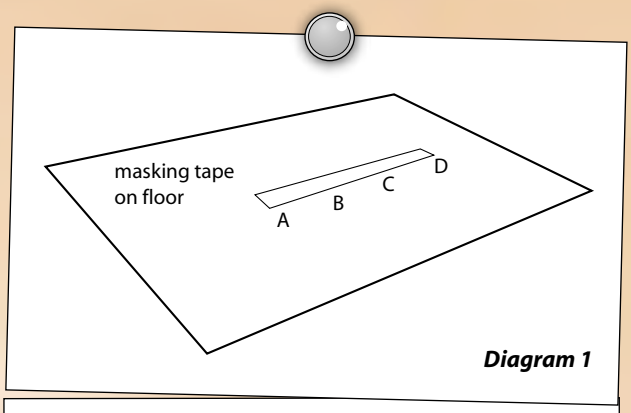


Diagram 1

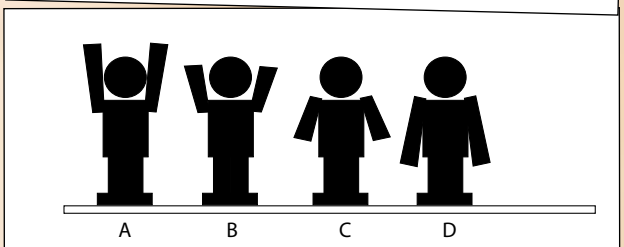


Diagram 2

Doin' the Wave

Segment 2

Conclusion

1. What was the fastest time? The slowest time? The average time?
2. How did the average time compare to the trial times?
3. Why would you want to know the velocity of a wave?
4. What might wind have to do with wave velocity?

Wave Velocity Chart

Trial number	Time	Velocity
1		
2		
3		
4		
5		

velocity = distance divided by time (v = d/t)

Remember: Your distance is 3 m.

To find the average velocity, add all the trial times and divide by 5. Using the new sum, calculate the average velocity (v = d/t).

Average velocity = _____

Extension

Visit a beach or a water park. Observe and measure the velocity of the waves as they form and break on shore. How do they compare to your wave velocity? What do you think would happen to the wave velocity in heavy winds? When the air is calm?

Answer Key

Segment 2

Sealz, Salz, Saldus, Sal, Hals, and More NaCl

1. Salt remained in the pie pan. When the water evaporated, the sodium chloride came out of the solution and formed a solid again
2. Ppt means parts per thousand. The average salinity of salt water is 35 ppt.
3. Yes, saltwater is denser and the increased density makes saltwater about 3% heavier than freshwater. However, the difference is so slight that it is not noticeable on a small scale.
4. The oceans are constantly in flux. In the tropics and other areas, such as the Mediterranean Sea, intense heat evaporates water and leaves a higher concentration of salt behind. When ocean waters freeze and ice forms, the ice is created from freshwater; thereby, also leaving a higher concentration of salt behind. Ocean waters near the mouths of freshwater rivers have lower salinity levels and so do areas that receive large amounts of rainfall.
5. As more salt was added, the pen cap began to float higher in the water. It floated higher because of the increased density of the water. Objects become more buoyant in denser water.
6. Answers will vary.
7. The tree house detectives researched currents to learn how the shoes and oil globs were carried to their beach. The salinity differences in ocean waters create currents.

Dense and Denser

1. The green saltwater sank to the bottom of the freshwater.
2. The blue freshwater rose to the top of the saltwater.
3. Freshwater from rivers and runoff flows into the ocean and floats on top of the saltwater. Saltwater is denser than fresh water. Because salt water is heavier, it sinks, and the lighter freshwater floats above it. Eventually, the waters will mix and become more or less equal in density.

Going Up or Going Down?

1. The warm water floated on top of the cold water because it is less dense. In warm water, the molecules are spread farther apart. There are fewer water molecules in hot water than in an equal volume of cold water.
2. The cold water sank to the bottom because it was denser (more molecules). Eventually, as the two waters mix, the warm water will cool and the cold water will warm until they become about the same temperature.
3. Answers will vary.

Getting Windy

1. The currents should move more rapidly on the far side of the island.
2. The water moves faster and begins to curve around the island.
3. The island diverted the path of the current. The current was stronger behind the island because the drop of color moved more quickly as it neared the back of the island.
4. The current went straight over the petri dish. It never curved or gained speed.
5. Answers will vary.
6. No. Once the currents encounter an obstacle, their direction changes.

Doin' the Wave

1. Answers will vary.
2. Answers will vary.
3. Answers will vary.
4. As wind increases, so does wave velocity.

On the Web

Under the Sea

1–4. Answers will vary.