National Aeronautics and
Space Administration

Langley Research Center
Hampton, VA 23681-2199

Educational Product

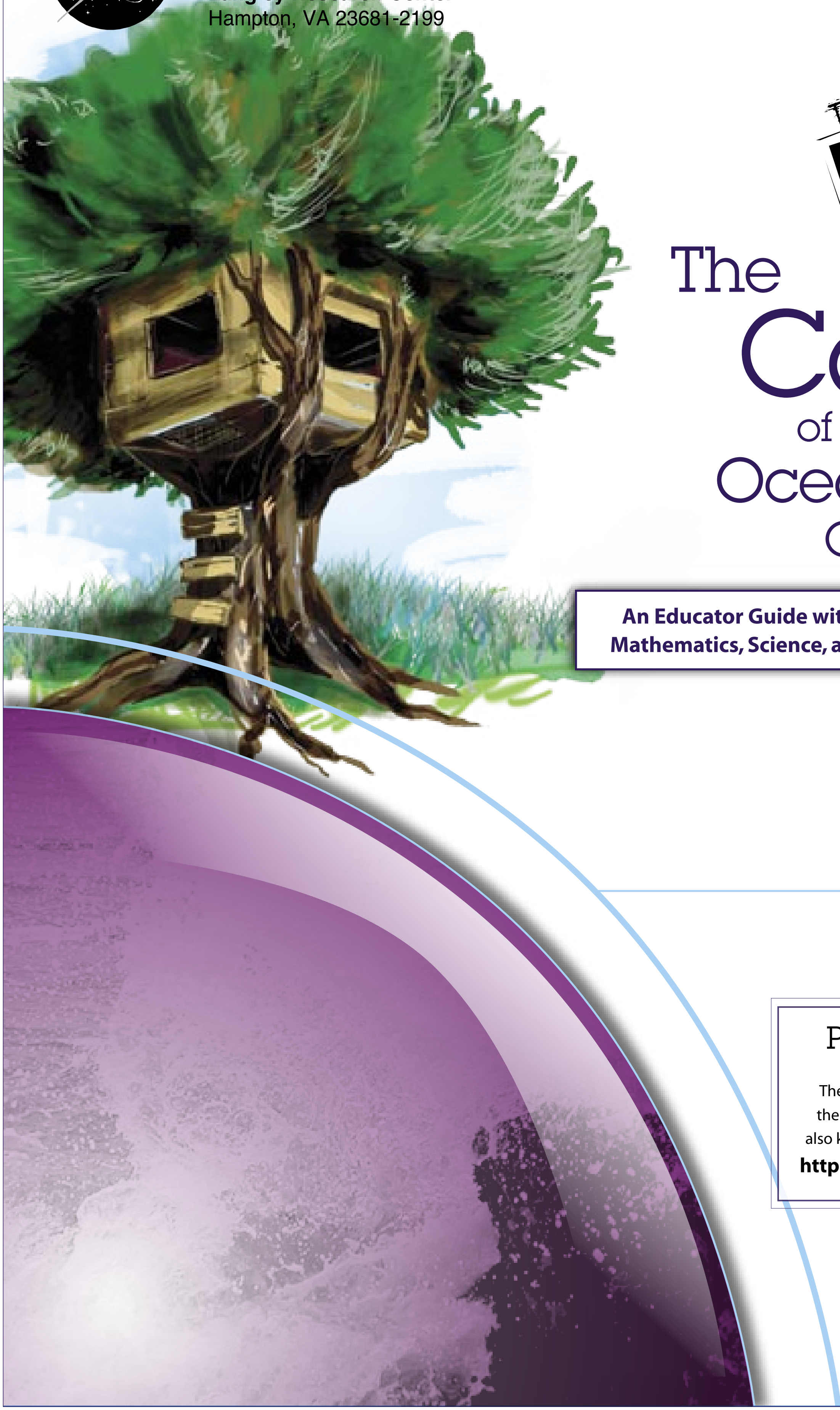
Educators	Grades 3–5

EG-2004-11-17-LARC

The NASA Sci Files™

The Case of the Ocean Odyssey

An Educator Guide with Activities in Mathematics, Science, and Technology



Please Note:

Our name has changed!
The NASA "Why" Files™ is now the NASA SCIence Files™ and is also known as the NASA SCI Files™.

http://scifiles.larc.nasa.gov

The Case of the Ocean Odyssey educator guide is available in electronic format through NASA Spacelink– one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the educator guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site: **http://scifiles.larc.nasa.gov**

www.swe.org

www.sbo.hampton.k12.va.us

www.buschgardens.com

www.cnu.edu

The NASA Science Files™ is produced by the NASA Center for Distance Learning, a component of the Office of Education at NASA's Langley Research Center, Hampton, VA. The NASA Center for Distance Learning is operated under cooperative agreement NCC-1-02039 with Christopher Newport University, Newport News, VA. Use of trade names does not imply endorsement by NASA.

The NASA SCI Files™

The Case of the Ocean Odyssey

An Educator Guide with Activities in Mathematics, Science, and Technology

Segment 1

Segment 2

Segment 3

Segment 4

For additional information about the NASA SCI Files™, contact Shannon Ricles at (757) 864-5044 or **s.s.ricles@larc.nasa.gov**.

Production of the NASA SCI Files™ is made possible by the generous support provided by the Society of Women Engineers (SWE); Busch Gardens, Williamsburg; Hampton City Public Schools; and the NASA Langley Research Center's Aerospace Vehicle Systems Technology Program Office.

Writers and Teacher Advisors: Shannon Ricles, Becky Jaramillo, and Michelle Fargo

Graphic Designer: René Peniza

Editor: Susan Hurd

Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kimlien.vu@swe.org** or visit the NASA SCI Files™ web site **http://scifiles.larc.nasa.gov**

The NASA Sci Files™

Program Overview

The tree house detectives are eager to help clean up their community beach but are surprised when they arrive to find a beach full of tennis shoes and oil globs. Curious as to how the tennis shoes and oil ended up on their beach, the detectives set out to solve their next case, *The Case of the Ocean Odyssey*.

After listening to a KSNN™ report, the tree house detectives are convinced that the shoes were in a container that fell off a cargo ship near the Virginia coast. Bianca cautiously reminds the detectives not to jump to conclusions, so they meet Dr. Eileen Hofmann from Old Dominion University at the wave pool in Water Country USA, Williamsburg, Virginia. Dr. Hofmann explains how tides are created and uses Jacob as a human guinea pig to demonstrate how water particles move within waves. This new knowledge sparks the detectives to visit Dr. D on the *Maury*, a research vessel operated by Tidewater Community College in Norfolk, Virginia. Dr. D helps the detectives understand how oceans became salty and demonstrates density differences in salinity.

Realizing that there are many different kinds of currents in the ocean, the detectives visit Dr. Chris Martens in Key Largo, Florida. 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 explains that differences in salinity and temperature can create density currents. He also describes upwellings and thermohaline circulation, the global conveyor belt of our oceans. Next, Dr. Textbook gives some historical information about the Gulf Stream, which motivates the detectives to learn more about surface currents. Bianca sets off to visit Dr. David Adamec at NASA Goddard Space Flight Center in Greenbelt, Maryland. Dr. Adamec helps Bianca understand how the Coriolis effect, wind, and topography affect surface currents in the ocean. He also explains the importance of oceans to our climate and why NASA uses various instruments and tools to learn more about oceans. Meanwhile, back at Water Country USA, Dr. D, Catherine, and RJ conduct an experiment to measure the speed of the Hubba Hubba Highway. They also discover that the swift moving current is too much for even really strong swimmers!

While in Houston, Texas, oil country, Jacob sets out to learn more about oil—black gold, Texas Tea. He visits Paul Bernhard in the Wiess Energy Hall at the Houston Museum of Natural Science who explains how oil was formed millions of years ago. Curious as to how oil is found and extracted from the ground, Mr. Bernhard suggests that Jacob visit Mr. Kent Wells at the Ocean Star, an offshore drilling rig and museum. Mr. Wells explains how a well is drilled and how production is completed once oil is found. Mr. Wells also tells Jacob some interesting facts about oil, which spurs the tree house detectives into action. Kali visits Ms. Jennifer Miselis at the Virginia Institute of Marine Science (VIMS), who describes ocean floor topography and gives them another clue to the mystery.

The tree house detectives think they are getting close to solving the case but become concerned over the environmental impact that the oil has on their community and wildlife. They dial-up a NASA SCI Files™ Kids' Club at Key Largo School in Key Largo, Florida, where Mrs. Ann Dunn's class is conducting an experiment to learn more about cleaning up an oil spill. After discovering that cleaning up oil is not so easy, RJ goes to NASA Wallops Flight Facility, located on Virginia's Eastern Shore, to talk with Ms. Sue Fields and Dr. John Moisan. Ms. Fields explains the environmental impact of oil and why it is so important to contain an oil spill before it reaches land. Dr. Moisan helps the detectives put the final pieces together to solve the mystery as he explains coastal currents. Finally, it is off to Dr. D's lab, where the tree house detectives wrap it up and get confirmation on their hypothesis. Another case solved!

National Science Standards (Grades K-4)

STANDARD	SEGMENT			
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Systems, orders, and organization	◆	◆	◆	◆
Evidence, models, and explanations	◆	◆	◆	◆
Change, constancy, and measurement	◆	◆	◆	◆
Evolution and equilibrium	◆		◆	
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	◆	◆	◆	◆
Understandings about scientific inquiry	◆	◆	◆	◆
Physical Science (B)				
Properties of objects and materials	◆	◆		◆
Position and motion of objects	◆	◆		◆
Light, heat, electricity, and magnetism		◆		
Earth and Space Science (D)				
Properties of earth materials				◆
Objects in the sky	◆	◆	◆	◆
Changes in earth and sky	◆	◆	◆	◆
Science and Technology (E)				
Abilities of technological design	◆	◆	◆	◆
Understandings about science and technology	◆	◆	◆	◆
Science in Personal and Social Perspectives (F)				
Types of resources	◆	◆	◆	◆
Changes in environment	◆	◆	◆	◆
History and Nature of Science (G)				
Science as a human endeavor	◆	◆	◆	◆

National Science Standards (Grades 5–8)

STANDARD	SEGMENT			
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Systems, order, and organization	◆	◆	◆	◆
Evidence, models, and explanations	◆	◆	◆	◆
Change, constancy, and measurement	◆	◆	◆	◆
Evolution and equilibrium	◆		◆	
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	◆	◆	◆	◆
Understandings about scientific inquiry	◆	◆	◆	◆
Physical Science (B)				
Properties and changes of properties in matter	◆	◆	◆	◆
Motion and forces	◆	◆		
Transfer of energy	◆	◆	◆	
Earth and Space Science (D)				
Structure of the earth system	◆	◆	◆	◆
Earth's history	◆	◆	◆	◆
Earth in the solar system	◆			
Science and Technology (E)				
Abilities of technological design	◆	◆	◆	◆
Understanding about science and technology	◆	◆	◆	◆
Science in Personal and Social Perspectives (F)				
Populations, resources, and environments	◆		◆	◆
Natural hazards	◆		◆	◆
Risks and benefits			◆	◆
Science and technology in society			◆	◆
History and Nature of Science (G)				
Science as a human endeavor	◆	◆	◆	◆
Nature of science	◆	◆	◆	◆
History of science	◆	◆	◆	◆

National Mathematics Standards for Grades 3–5

STANDARD	SEGMENT			
Number and Operations	1	2	3	4
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	◆	◆		
Understand meanings of operations and how they relate to one another.	◆	◆		
Compute fluently and make reasonable estimates.	◆	◆		
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols.		◆		
Use mathematical models to represent and understand quantitative relationships.		◆		
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	◆	◆	◆	◆
Apply appropriate techniques, tools, and formulas to determine measurements.	◆	◆	◆	◆
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	◆	◆	◆	◆
Develop and evaluate inferences and predictions that are based on data.		◆	◆	◆
Understand and apply basic concepts of probability.		◆		
Problem Solving				
Build new mathematical knowledge through problem solving.	◆	◆	◆	◆
Solve problems that arise in mathematics and in other contexts.	◆	◆	◆	◆
Apply and adapt a variety of appropriate strategies to solve problems.	◆	◆	◆	◆
Monitor and reflect on the process of mathematical problem solving.	◆	◆	◆	◆

National Mathematics Standards for Grades 3-5

STANDARD	SEGMENT			
Communication	**1**	**2**	**3**	**4**
Organize and consolidate mathematical thinking through communication.	◆			
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.	◆			
Analyze and evaluate the mathematical thinking and strategies of others.	◆			
Use the language of mathematics to express mathematical ideas precisely.	◆			

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT			
Basic Operations and Concepts	**1**	**2**	**3**	**4**
Use keyboards and other common input and output devices efficiently and effectively.	◆	◆	◆	◆
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	◆	◆	◆	◆
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.				◆
Discuss basic issues related to responsible use of technology and information and describe personal consequences of inappropriate use.				◆
Technology Productivity Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	◆	◆	◆	◆
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	◆	◆	◆	◆
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	◆	◆	◆	◆
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	◆	◆	◆	◆

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT			
Technology Research Tools	1	2	3	4
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	◆	◆	◆	◆
Use technology resources for problem solving, self-directed learning, and extended learning activities.	◆	◆	◆	◆
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	◆	◆	◆	◆
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	◆	◆	◆	◆
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	◆	◆	◆	◆
Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.	◆	◆	◆	◆

International Technology Education Association Standards for Technological Literacy Grades 3-5

STANDARD	SEGMENT			
The Nature of Technology	1	2	3	4
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	◆	◆	◆	◆
Standard 2: Students will develop an understanding of the core concepts of technology.	◆	◆	◆	◆
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	◆	◆	◆	◆
Technology and Society				
Standard 5: Students will develop an understanding of the effects of technology on the environment.	◆	◆	◆	◆
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	◆	◆	◆	◆
Standard 7: Students will develop an understanding of the influence of technology on history.		◆		
The Designed World				
Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.			◆	◆

National Geography Standards

STANDARD	SEGMENT			
The geographically informed person knows and understands:	**1**	**2**	**3**	**4**
The World in Spatial Terms				
How to use maps and other graphic representations, tools, and technologies to acquire process and report information from a spatial perspective		◆	◆	◆
Places and Regions				
The physical and human characteristics of places	◆	◆	◆	◆
Physical Systems				
The physical process that shape the patterns of Earth's surface		◆	◆	
Environment and Society				
How human actions modify the physical environment			◆	◆
The changes that occur in the meaning, use, distribution, and importance of resources			◆	◆
The Uses of Geography				
How to apply geography to interpret the past		◆		
How to apply geography to interpret the present and plan for the future			◆	◆

Segment 1

The tree house detectives head to the beach for a fun-filled "Clean the Bay Day" where they volunteer to clean the shoreline of their local beach. While combing the beach for trash, the detectives find an unusual kind of beach debris—tennis shoes and oil globs. Curious as to where so many tennis shoes could have come from and why there is oil on them and the beach, the detectives decide this is their next case. When I.M. Lissening reports that a cargo ship lost a container at sea off the Virginia coast, the detectives conclude that the morning tides brought in the shoes and oil. However, they remember that it's not always wise to jump to conclusions and agree that they need to do a little more research. They contact Dr. Eileen Hofmann at Old Dominion University to learn more about tides. Dr. Hofmann agrees to meet them at the Wave Pool in Water Country USA (Williamsburg, Virginia) where Jacob, bobbing in the waves, becomes a human experiment. Next, the tree house detectives head to the boat docks to meet Dr. D on the research vehicle, *Matthew F. Maury*, Tidewater Community College's research boat, to learn that oceans are not as simple as they thought.

Objectives

Students will

- learn about buoyancy
- determine why certain items float
- calculate the rate at which items sink
- understand tides and tidal bulges
- read and interpret tide tables
- demonstrate the circular movement of waves

Vocabulary

basin—a low area that contains an ocean

buoyancy—the tendency of a liquid or gas to cause less dense objects to float or rise to the surface

cargo container—a receptacle for holding or carrying freight; usually transported by ship, airplane, truck, or train

current—the part of a fluid body moving consistently in the same direction; the swiftest part of a stream

gravitational force—an attractive force that exists between all objects

oil—a liquid formed as ancient plants and animals decay; burned as a fossil fuel and used to make lubricants and plastics

salinity—a measure of the amount of solids (mostly salts) dissolved in seawater

tide—the periodic change in the surface level of the oceans caused by the gravitational forces of the Sun and Moon on the Earth

wave—a series of ripples moving across the surface of a liquid, especially a large, raised ridge of water moving across the surface of the sea

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. Before viewing Segment 1 of *The Case of the Ocean Odyssey*, read the program overview to the students. List and discuss questions and preconceptions that students may have about how oceans are formed, the tides and currents in oceans, and what causes ocean waves.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the Problem-Based Learning tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log and Rubric—Students' printable log with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method and Flowchart—Chart that describes the scientific method process
3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. They can be printed ahead of time from the **Educators** area of the web site in the **Activities/ Worksheet** section under **Worksheets** for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.
4. **"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. You can print them by selecting **Educators** on the web site in the **Activities/Worksheet** section under **Worksheets** for the current episode.

View Segment 1 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 watching 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. Students should work in groups or as a class to discuss and list what they know about the oceans of the world. Have the students conduct research on the difference between currents, tides, and waves. Brainstorm ideas about how the tennis shoes may have ended up on the beach. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide them with the information needed.
4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools** section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
5. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. 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 Disappearing Dirt*. In the green box, click on **Download the Educator Guide**.

a. In the Educator Guide you will find

a. **Segment 4** – *Riding the Waves*

Close the PDF window to return to the Educators Activities page. 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**.

b. In the Educator Guide you will find

a. **Segment 1** – *Around and Around It Goes (water cycle)*

b. **Segment 1** – *A Cycling We Will Go (water cycle)*

c. **Segment 1** – *Water, Water Everywhere (usable water on Earth)*

7. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the 2004–2005 Season and click on *Lost at Sea*.
8. To begin the PBL activity, read the scenario *(Here's the Situation)* to the students.

- Read and discuss the various roles involved in the investigation.
- Print the criteria for the investigation and distribute.
- Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. The **Research Rack** is also located in the **Tree House**.

9. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
10. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.
11. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Careers

cargo transport engineer
customs officer
marine chemist
marine engineer
oceanographer
ship captain

Resources *(additional resources located on web site)*

Books

Baker, Lucy and Jason Page: *Oceans*. Creative Publishing International, 2000, ISBN: 1587284596.

Berger, Melvin and Gilda Berger: *What Makes an Ocean Wave?: Questions and Answers about Oceans.* Scholastic, Inc., 2001, ISBN: 0439148820.

Demas, Corinne: *Disappearing Island*. Simon and Schuster, 1999, ISBN: 068980539X.

Ganeri, Anita: *Oceans*. Houghton Mifflin Company, 2002, ISBN: 0753454653.

Herman, G.: *Creeping Tide*. Kane Press, 2003, ISBN: 1575651289.

Jacobs, Marian: *Why Does the Ocean Have Tides?* Rosen Publishing Group, 2003, ISBN: 082395272X.

MacQuitty, Miranda: *Eyewitness: Ocean*. DK Publishing, Inc., 2000, ISBN: 0789460343.

Mason, Adrienne: *Oceans: Looking at Beaches and Coral Reefs, Tides and Currents, Seaweeds and Other Ocean Wonders.* Kids Can Press, 1997, ISBN: 1550741470.

Norris, Paul: *Aquaman's Guide to the Ocean*. DK Publishing, Inc., 2004, ISBN: 0756602300.

Simon, Seymour: *Oceans*. Morrow, William, and Co., 1997, ISBN: 0688154786.

Video

BBC: *Tidal Seas/Coasts*
Grades 6–8

Discovery Channel: *Understanding Oceans*
Grades 6–12

Web Sites

Tide and Current Predictor
Find the current prediction of tidal heights and current speeds for various locations around the world.
http://tbone.biol.sc.edu/tide/sitesel.html

National Oceanic and Atmospheric Administration (NOAA)
Visit NOAA's main web site to learn about oceans, fisheries, charting and navigation, weather, hurricane tracking, climates, and much more. There are also great educational resources for both teachers and students.
http://www.noaa.gov/

NOAA – About Water Levels, Tides, and Currents
On this NOAA web site, you can learn about what makes tides, the history of tidal analysis and prediction, tide-predicting machines, how and why we measure water levels, and the challenges of measuring water currents.
http://co-ops.nos.noaa.gov/about2.html#ABOUT

NOAA's National Ocean Service – Tides and Currents
Learn all about tides, tidal and storm surges, and water levels.
http://www.nos.noaa.gov/topics/navops/ports/welcome.html

Lunar Tides
The tides at a given place in the Earth's oceans occur about an hour later each day. Since the Moon passes overhead about an hour later each day, it was long suspected that the Moon was associated with tides. Visit this web site to learn more about lunar tides.
http://csep10.phys.utk.edu/astr161/lect/time/tides.html

Why Tides?
This web site has a great animation of the gravitational action of the Sun and Moon on the Earth's oceans and tides.
http://www.sfgate.com/getoutside/1996/jun/tides.html

Rip Tides
This web site contains information on rip tides, including an audio and graphic explanation of rip tides and safety information on what to do if you are caught in a rip tide.
http://ww2010.atmos.uiuc.edu/%28Gh%29/guides/mtr/hurr/damg/rip.rxml

Water on the Move
The Oceans Alive! web site has some great information about currents, wind and waves, and tides.
http://www.mos.org/oceans/motion/index.html

Why Is the Ocean Salty?
Visit this site to learn how salty the ocean is, the origin of the sea, sources of the salt in the ocean, and many other facts about the salt in the ocean.
http://www.palomar.edu/oceanography/salty_ocean.htm

NASA Jet Propulsion Laboratory Ocean Game
This NASA web site contains all the information and materials needed to make a board game to learn about continents, oceans, and ocean currents. You can download everything you need for the game from this site.
http://sealevel.jpl.nasa.gov/education/jason-1-game.html

Eco-Pro Ocean Home
This web site has a wealth of information on oceans as well as many links to other ocean related web sites.
http://www.eco-pros.com/oceanhome.htm

Activities and Worksheets

Boats Afloat

Segment 1

Purpose

To learn what buoyancy is

To determine characteristics that make an object buoyant

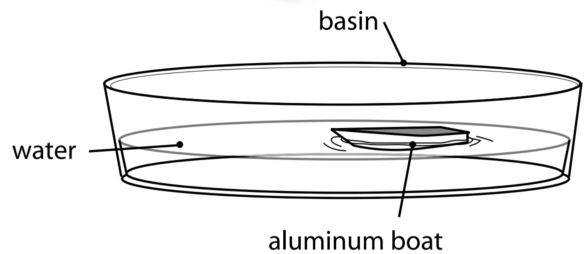
Materials

various lightweight materials (i.e., foam trays, cups, straws, paper plates, toothpicks)
various weighted materials (i.e., pennies, rocks, paper clips)
large basin, sink, or inflatable pool
tap water
scale
science journal

Background

Some objects, when placed in water, will float, while others will sink. Some objects neither float nor sink. The objects' ability to float or sink is a function of buoyancy. We call objects that float, positively buoyant. Objects that sink are called negatively buoyant. Objects that neither float nor sink are called neutrally buoyant. A Greek mathematician named Archimedes defined the principle of buoyancy: *Any object, wholly or partly immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object.* This statement is known as Archimedes' principle. Think about what happens when you take a bath. When you fill the bathtub half full with water and then get in, the water level rises. The weight of your body displaces the water. Saltwater is heavier, or denser, than freshwater, so objects in saltwater tend to float more easily than they do in freshwater. Objects of greater density than the fluid will sink, while objects of lesser density will float. Shape and position also factor into whether or not an object will float. A steel boat turned on its end will not float; however, the same steel boat will float when turned horizontally.

Procedure



1. Fill your basin, sink, or pool 1/2 full with water.
2. Survey the lightweight materials available to you.
3. In your science journal, draw a design of a boat to float in the water by using only the available materials.
4. Following your design, build your boat.
5. Place your boat in the water and see if it floats.
6. If necessary, modify your boat design until it floats.
7. Record your observations and design changes in your science journal.
8. Using paper clips, pennies, or other objects, add weight to the boat by adding one object at a time. Continue until the boat no longer floats.
9. Retrieve the objects from the water and dry them.
10. Weigh the objects on a scale to determine the amount of weight your boat could hold before sinking. (Don't include the last object that sank the boat.)
11. Record your findings in your science journal.
12. Using different materials, repeat steps 2–11.

Boats Afloat

Segment 1

Conclusion

1. What types of materials were more buoyant? Why?
2. What shape of boat was more buoyant? Why?
3. Did one boat hold more weight than the other boat? Why?
4. What do you think would happen if you added salt to the water?

Extension

1. Repeat the experiment with saltwater. Add salt to the water in the basin and repeat the steps. Did it make a difference? Explain the difference between saltwater and freshwater buoyancy?
2. Fill two jars 1/2 full with water. The mouth of the jar should be large enough for an egg to fit. Label one jar "freshwater" and the other jar "saltwater." Add 120 mL salt to the "saltwater" container and stir. Place an uncooked egg in each jar and observe. Is there a difference between salt- and freshwater density? How do you know?

Going Up or Going Down?

Segment 1

Purpose

To determine which items float and which items sink

To understand buoyancy

Background

Have you ever wondered why heavy objects such as large trees float while lightweight objects such as a small grain of sand sinks? When scientists want to know if an object will sink or float, they find out its density. The density of a substance is the weight of a standard amount of the substance. The amount that scientists usually use is the cubic centimeter cubed (cm^3). A cm^3 is a cube that is 1 cm long by 1 cm wide by 1 cm deep. To find out if an object will sink or float in water, you have to compare the weight of the object to the weight of an equal amount of water. If a cm^3 of a substance weighs less than a cm^3 of water, the substance will float.

Materials

Per Group

pencil
masking tape
metric ruler
2 tea light candles
modeling clay
water
1 cup
table
large basin
science journal

Procedure

1. Tape a pencil to a table. See diagram 1.
2. Roll 2 small pieces of tape, sticky side out, and stick one on each end of the ruler. See diagram 2.
3. Remove the candles from their metal containers.
4. Place the empty metal containers on the rolled-up pieces of tape.
5. Place the ruler on the pencil so that it is as evenly balanced as possible. See diagram 3.
6. The number directly above the pencil in the center is your balance point. Record the balance point in your science journal.
7. Being careful not to move the ruler from its balance point, replace one of the candles in its metal container.
8. Slowly fill the empty metal container with water.
9. Which is heavier—the wax or an equal volume of water?
10. Predict whether or not the wax will float in water.
11. Fill a large basin with water.
12. Test your prediction by placing the candle in the basin of water. Record your observations in your science journal.
13. Remove the water and candle from the metal containers.
14. Fill one metal container with clay.
15. Reset your ruler on the balance point.
16. Slowly fill the empty container with water.
17. Which is heavier—the clay or an equal volume of water?
18. Predict whether or not the clay will float in water.
19. Test your prediction by placing the clay in the basin of water. Record your observations.

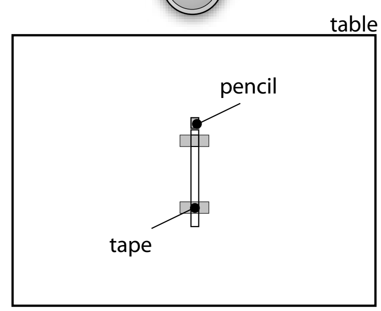


Diagram 1

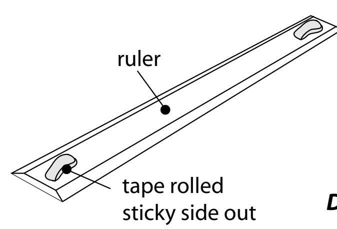


Diagram 2

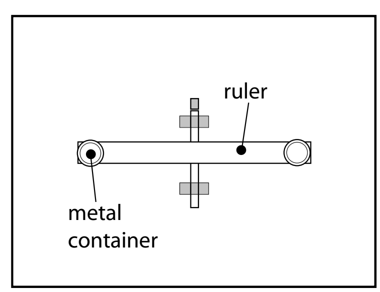


Diagram 3

Going Up or Going Down?

Segment 1

Conclusion

1. Did the wax float? The clay? Why or why not?
2. What do you think would happen if you changed the shape of the wax or clay?
3. What do you think would happen if you used saltwater instead of freshwater?
4. Why did you have to have an equal amount of water to compare the weights?

Extension

1. Test other items to see if they will float in water. Try changing the shape of some items if possible. Did it make a difference? Add salt to the water. Repeat the activity with saltwater. Does it change the result?
2. Fill 2 clear cups with water. Add salt to one cup until it will no longer dissolve. Label the cups "saltwater" and "freshwater." Have an adult cut a carrot into slices. Place a carrot slice in each cup. What did you observe? Why do you think it happened? What does this experiment tell you about the density of fresh- and saltwater? About the buoyancy of a carrot?
3. Compare other liquids such as vegetable oil, water, and corn syrup. Which liquid is the heaviest? Place equal amounts of the three liquids in a glass jar with the liquid you think is the heaviest on the bottom and observe. Optional: Use food coloring to differentiate between the layers.

Ahoy! Container Overboard

Segment 1

Purpose

To calculate the speed of a moving object

Background

Each year, manufacturers around the world ship more than 100 million containers of cargo, each the size of a semi-truck across the world's oceans and seas. Each year more than 10,000 cargo containers fall overboard and are lost on the high seas. Storms are often to blame. Most dry containers are steel boxes that weigh between two and four tons. These containers are built to be weatherproof but not watertight. If the containers are empty, they sink quickly as the water fills the inside of the box. Most cargo containers have small openings or distortions that allow seawater to enter at a very slow rate (about 11 kg per hour). The containers will eventually become deadweight, or completely waterlogged, so they will no longer float. If the containers are full, they may float for a while. Air trapped in the cargo container may hold a container on the surface of the water until the cargo becomes waterlogged. Marine insurance companies estimate that a 7-meter container would take some 57 days to reach the waterlogged weight necessary to sink it. A 14-meter container could float for some 183 days. The speed at which the container sinks depends on the shape and content of the boxes. The formula to calculate speed is simple: Speed = Distance ÷ Time

Materials

- 2-liter soda bottle
- scissors
- metric ruler
- tape
- watch or clock with a second hand
- peanuts in shell
- tap water

Procedure

1. Remove the label from the soda bottle.
2. With the help of an adult, carefully cut the top off the soda bottle approximately 10 cm from the opening.
3. Tape a metric ruler to the outside of the bottle so that the zero is at the bottom of the bottle and the ruler is touching the table. See diagram 1.
4. Fill the bottle with water so that the water level is about 3–5 cm below the top. Try to make the water level line even with a whole number on the ruler.
5. In the chart, write your prediction for the speed at which a whole peanut will fall.
6. Remove a whole peanut from the shell and place it on the surface of the water.
7. Use a stopwatch or clock with a second hand to time the peanut as it sinks. Record the time in the chart.
8. Measure the distance that the peanut fell and record the distance in the chart.
9. Use the formula and calculate the speed. Remember that the speed of the peanut = distance the peanut sinks ÷ the time it took the peanut to sink to that distance.
10. Repeat this experiment at least two more times and find the average speed for a whole peanut.
11. Predict whether a half-peanut will sink faster or slower than a whole peanut and record your prediction in the chart.
12. Remove a second peanut from the shell and split the peanut into two halves.
13. Place the half-peanut on the surface of the water.
14. Repeat steps 7–10.
15. Predict what you think the speed might be for 1/4 of a peanut.
16. Repeat steps 6–10.
17. Try an even smaller piece and calculate its speed.

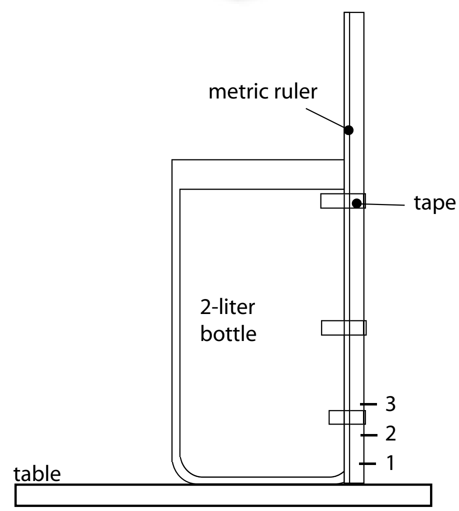


Diagram 1

Ahoy! Container Overboard

Segment 1

Chart

Peanut	Prediction	Distance	Time	Speed	Average speed
Whole					
Trial 1					
Trial 2					
Trial 3					
Half					
Trial 1					
Trial 2					
Trial 3					
1/4					
Trial 1					
Trial 2					
Trial 3					
Other					
Trial 1					
Trial 2					
Trial 3					

Conclusion

1. What is deadweight?
2. Why would cargo managers calculate the speed of a sinking object?
3. Based on the calculations you made, do you think a larger cargo box or a smaller cargo box would float longer?
4. What other factors might affect the speed at which the cargo box sinks?

Extension

Find out more about lost cargo containers and the insurance companies who must pay for them. The news of containers lost overboard is seldom publicized. Concern over dangers of lost containers to smaller craft and passenger ships has led the International Marine Organization to call for mandatory reporting of all cargo losses within a specific amount of time. Because most lost containers will eventually sink, are they a safety issue? Consider this issue from the perspectives of different people involved in the cargo transportation business. Would the cargo company view the loss of the container the same way that the company who sent it or should receive it would? Choose a role and decide what your reaction to the loss would be. Present the different points of view to a mock committee of the International Marine Organization.

Suggested roles: ship owner, exporter, importer, insurer, cruise ship captain, commercial fisherman, or pleasure boat owner

Tidying Up the Tides

Segment 1

Materials

Tide Table, page 25
Tide Graph, page 26
pencil
highlighter

Purpose

To read and interpret tide tables

Background

Ocean tides are affected most by the pull of the Moon on Earth. The Moon's gravity pulls the ocean water towards it, causing a bulge on each side of the Earth. These bulges are where the high tides occur, and the areas without the bulges are where the low tides occur. Most coastal areas on Earth experience two high and two low tides each day. However, some areas, such as the Gulf of Mexico, only experience one high and one low tide per day. Tide researchers gather tide data and can even predict future tides. Knowing when high and low tides will occur in an area is extremely important to the people who live along the coast and to ocean going vessels that have to navigate through the waters.

Procedure

1. Use the Tide Table to plot a graph of tide data.
2. Choose a date in July 2004.
3. Highlight the date you chose on the worksheet.
4. Copy the data from this date onto the top of your Tide Graph worksheet.
5. Plot the data onto the graph.
6. Connect the points (coordinates).
7. Find the range of tides for July 2004 by taking the highest tide and subtracting the lowest tide. Record your answer on the worksheet.
8. Find the mean of tides by taking all the tide values in feet and adding them together. Divide the answer by the number of tides. Record your answer.
9. Find the median of tides by sorting the tides in ascending order. If the list is odd, the middle number is the median. If the list is even, add the 2 middle numbers together and divide by 2. Record your answer.
10. Find the mode by looking to see the most frequently occurring tide value. Record your answer.

Conclusion

1. What was the highest tide value? The lowest?
2. What did your graph look like after you connected the points (coordinates)?
3. What do the range, mean, median, and mode tell you about the tides for July 2004 in Wallops Island, Virginia?
4. Why would a Navy aircraft carrier be concerned with the tides in an area it travels through?

Extensions

1. Use the Internet to find a tide table for Wallops Island, Virginia for a different month. Find the range, mean, median, and mode of the tides for that month. Compare the data to the data from July 2004. Is there a difference? Why or why not?
2. In areas where there is a large difference between the water level of high and low tides, tides can be used to generate electricity. Research how tidal energy is being tapped and create a report by using posters, PowerPoint, or other forms of media to explain the process and its benefits and drawbacks. Be sure to include whether tapping tidal energy is beneficial or harmful to the environment.

Tidying Up the Tides

Tide Table

*Next Day – The tide appeared early the next morning; there will only be 3 tides for that date

Tide Table - Wallops Island, Virginia 2004

Date	1st *Tide AM*	Feet	2nd *Tide AM* (except when noted)	Feet	3rd *Tide PM*	Feet	4th *Tide PM*	Feet
1	1:08	-0.1	6:54	3.3	12:57	-0.3	7:29	5.0
2	2:03	-0.2	7:50	3.4	1:52	-0.4	8:24	5.1
3	2:56	-0.3	8:45	3.4	2:46	-0.4	9:19	5.0
4	3:48	-0.3	9:40	3.5	3:41	-0.3	10:12	4.8
5	4:40	-0.2	10:35	3.5	4:37	-0.3	11:04	4.5
6	5:32	-0.1	11:29	3.5	5:35	-0.1	11:54	4.1
7	6:23	0.0	12:23 PM	3.4	6:35	0.1	*Next day*	
8	12:45	3.7	7:13	0.1	1:20	3.4	7:36	0.3
9	1:38	3.4	8:01	0.1	2:19	3.4	8:38	0.3
10	2:33	3.0	8:49	0.2	3:18	3.5	9:40	0.5
11	3:29	2.8	9:36	0.3	4:12	3.6	10:42	0.5
12	4:23	2.7	10:23	0.3	5:02	3.7	11:39	0.5
13	5:13	2.7	11:11	0.3	5:48	3.8	*Next day*	
14	12:27	0.4	5:59	2.7	11:57	0.3	6:31	3.9
15	1:09	0.4	6:43	2.8	12:42	0.2	7:14	4.1
16	1:47	0.3	7:27	2.9	1:25	0.2	7:56	4.1
17	2:24	0.3	8:09	3.0	2:06	0.1	8:37	4.2
18	3:01	0.3	8:51	3.1	2:46	0.1	9:17	4.2
19	3:38	0.3	9:33	3.2	3:27	0.1	9:57	4.2
20	4:16	0.3	10:14	3.3	4:10	0.2	10:35	4.1
21	4:55	0.3	10:56	3.4	4:55	0.3	11:14	4.0
22	5:35	0.3	11:39	3.5	5:45	0.3	11:56	3.8
23	6:17	0.3	12:26	3.6	6:40	0.4	*Next day*	
24	12:41	3.6	7:03	0.2	1:18	3.8	7:38	0.4
25	1:34	3.4	7:52	0.2	2:16	3.9	8:41	0.4
26	2:33	3.2	8:45	0.1	3:18	4.1	9:46	0.3
27	3:36	3.1	9:42	0.1	4:21	4.4	10:52	0.3
28	4:39	3.1	10:43	0.0	5:22	4.6	11:56	0.1
29	5:40	3.2	11:44	-0.1	6:20	4.8	*Next day*	
30	12:55	0.0	6:38	3.3	12:43	-0.3	7:16	4.9
31	1:49	-0.1	7:34	3.5	1:40	-0.3	8:10	4.9

Range = highest tide – lowest tide = _______________

Mean = all tide values in feet/the number of tides = _________________

Median = sort the tide values in feet in ascending order; if the list is odd, the middle number is the median; if the list is even, add the 2 middle numbers together and divide by 2 = _________________

Mode = the most frequently occurring tide value in feet = _______________

Tidying Up the Tides

Tide Graph

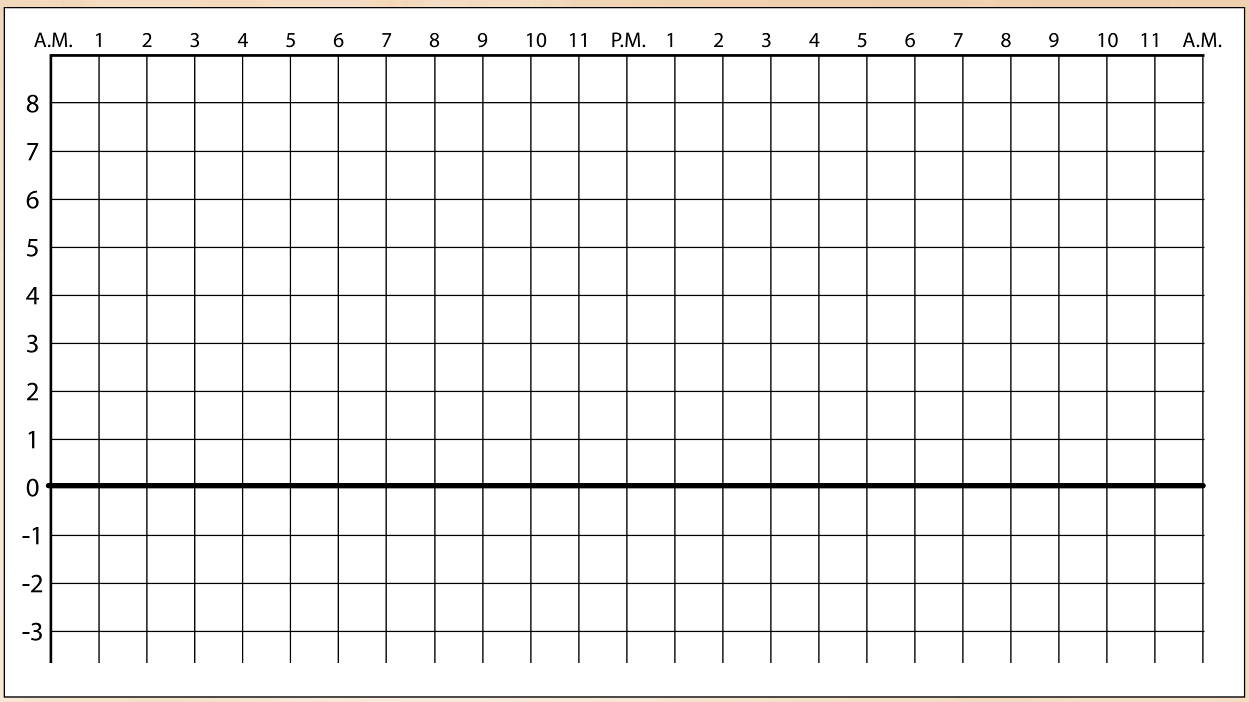
month day year

First Tide **Feet** **Second Tide** **Feet** **Third Tide** **Feet** **Last Tide** **Feet**

TIME

12 ··· **A.M.** ··· **12** ··· **A.M.** ··· **12**

(noon)



Wave on Wave

Segment 1

Purpose

To demonstrate the circular movement of waves

Materials

clear drinking glass
deeper clear glass jar
clear carbonated soda or seltzer water
4–5 raisins
science journal

Background

Waves are movements in which water alternately rises and falls. When you watch a wave, it looks like the water moves forward, but it doesn't. The water actually stays in about the same place. An object floating on the water will rise and fall as a wave passes, but the object will not move forward. Each particle of water in a wave moves around in a circle. Energy moves forward while water particles remain in the same place.

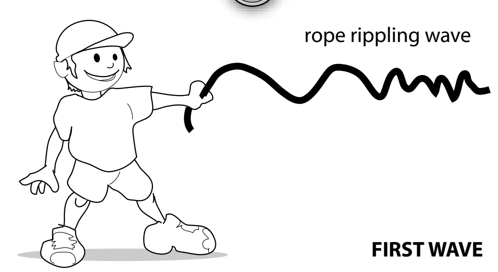
First Wave

To demonstrate how waves transfer energy but not water particles hold a 2-meter rope in your hand and flip your wrist to start a wave moving down the length of the rope. Notice that the wave moves across the entire length of the rope, but note that the rope did not move any distance. It is still in your hand.

Second Wave

To demonstrate how water particles move in a circular motion, try the following experiment.

NOTE: *The energy that causes waves is called a disturbing force. Wind blowing across the ocean's surface provides the disturbing force for wind waves. Other forces, such as gravitational pull, change because of atmospheric pressure, or earthquakes may also cause waves of different sizes. In the following activity, the disturbing force is created by the release of carbon dioxide gas bubbles. The bubbles collect around the raisin, acting like tiny balloons to raise it to the surface. As the bubbles reach the surface and are released into the air, the raisins once again fall to the bottom of the glass.*



FIRST WAVE

Procedure

1. Pour the carbonated soda into the clear drinking glass.
2. Put the raisins in the glass.
3. Observe the motion of the raisins as they rise, spin, and fall to the bottom of the glass.
4. In your science journal, record your observations and draw a diagram of the raisins by using arrows to show direction.
5. Repeat steps 1–4 using a deeper glass jar.
6. Compare the movement of the raisins in the two containers.

Conclusion

1. What kind of movement can you observe in this activity?
2. How is this movement like the movement of the waves in the ocean?
3. What can the tree house detectives learn from this activity?

Extension

Fill a clear plastic storage box or a glass baking dish with water. Float a cork or other object in the center of the container. Along the sides and bottom of the container, use masking tape to mark the approximate location of the cork. Use a spoon to gently make waves in the container and observe what happens to the cork. Did the cork move to the edge of the container? Explain why or why not.

Answer Key

Segment 1

Boats Afloat

1. Answers will vary.
2. Answers will vary.
3. Answers will vary.
4. More objects should be able to float.

Going Up or Going Down?

1. The wax should float because it is lighter than the water. The clay should sink because it is heavier than the water.
2. Answers will vary.
3. More objects should be able to float.
4. To compare density, the objects must be of equal quantity.

Ahoy! Container Overboard

1. Deadweight is anything that is completely waterlogged and can no longer float.
2. Cargo managers calculate the speed of a sinking object to decide whether or not they should retrieve the lost cargo.
3. Answers will vary.
4. Answers will vary.

Tidying Up the Tides

1. The highest tide value is 5.1. The lowest tide value is –0.4.
2. The graph should have resembled a wave.
3. The range, mean, median, and mode can tell you about the changes in the tide during a month.
4. Answers will vary.

Wave on Wave

1. The raisins move in a circular motion. They move up and then sink back down.
2. Water in waves moves in a circular motion.
3. The tree house detectives can learn that waves did not bring the tennis shoes to the beach.

On the Web

Dancing with the Tides

1. Low tide is in a line with the Earth, perpendicular to the bulge line.
2. The Earth's gravity prevents the bulging water from escaping into space.
3. The tidal bulges are a result of the Moon's gravitational pull and the Earth's rotation.

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.

   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.

Careers

marine biologist
ocean engineer
physical oceanographer
marine policy specialist
diver
cartographer

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

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

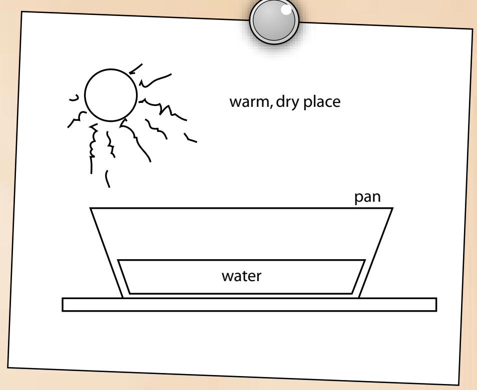
pie pan
water
table salt
1,000 red and blue construction paper dots
balance
large cup (1000 mL)
1000 mL graduated cylinders
plastic spoons
large jar
modeling clay
metric measuring spoon
cap from a pen
metric ruler
Ocean Salt Chart (p. 36)
science journal

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.

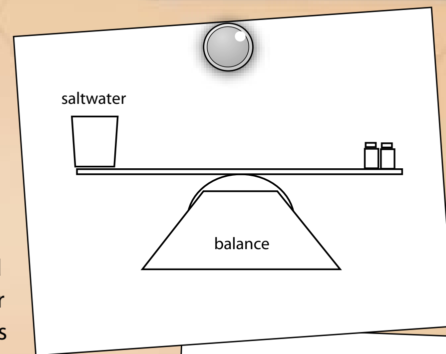
Procedure A: Ocean Water

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

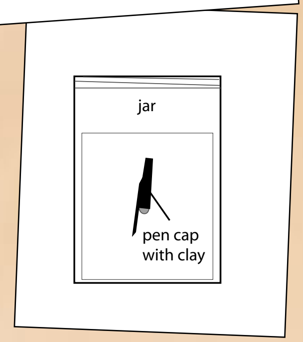
Segment 2

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 4° 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.

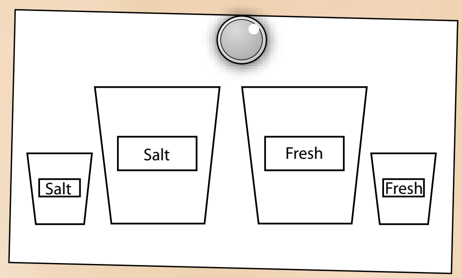
Teacher Note: Remember that density is defined as mass per unit volume: $D = M/V$

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.

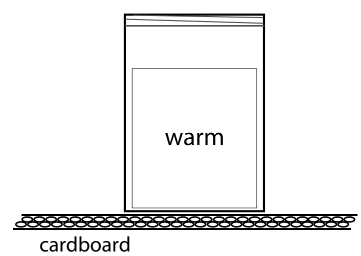


Diagram 1

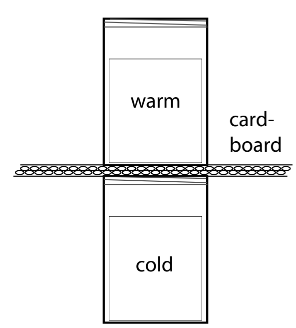


Diagram 2

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

Materials

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

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.

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.

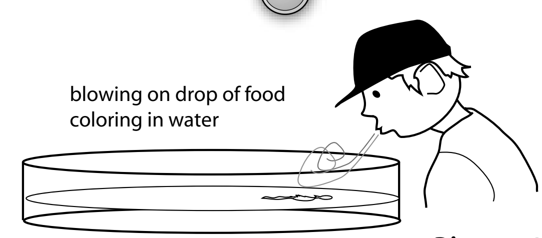


Diagram 1

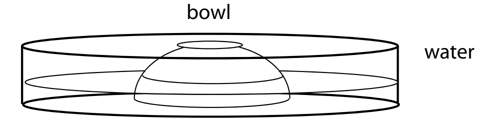


Diagram 2

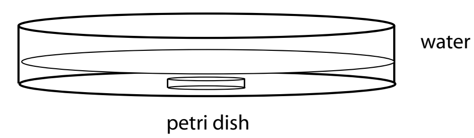


Diagram 3

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.

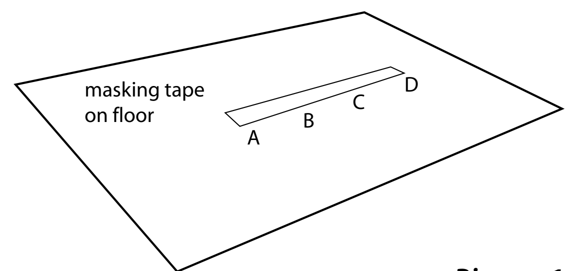


Diagram 1

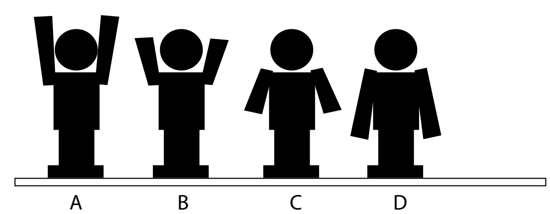


Diagram 2

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.

The NASA SCI Files™

The Case of the Ocean Odyssey

Segment 3

Armed with lots of information on ocean currents, the tree house detectives decide that they need to learn more about oil, how it forms, and how to drill for it. While in Houston with his family, Jacob stops by the Houston Museum of Natural Science to get a little help from Mr. Paul Bernhard. Mr. Bernhard explains how oil formed millions of years ago and the special conditions that were necessary for its formation. Next, Jacob visits Mr. Kent Wells, of BP Productions, at the Ocean Star drilling rig and museum in Galveston, Texas. As Mr. Wells shows Jacob around an actual drilling rig, he describes the process of drilling for oil. After learning from Bianca that there haven't been any recent oil spills, Jacob remembers something that Mr. Wells said and suggests that someone visit Ms. Jennifer Miselis at the Virginia Institute of Marine Science (VIMS) in Gloucester Point, VA. Ms. Miselis helps the tree house detectives better understand the topography of the ocean floor. With all this new information, the detectives think they might be close to solving the mystery of the tennis shoes and oil globs.

Objectives

Students will

- learn that different liquids vary in density.
- understand how oil forms.
- learn the devices used to drill for oil.
- learn that ocean floor topography varies.
- understand oil seeps.
- compare water pressure at different depths.
- realize that pressure increases as water depth increases.

Vocabulary

abyssal plain—the flat seafloor in the deep ocean

anaerobic—having or providing no oxygen

continental shelf—the part of every continent that extends under the ocean

continental slope—a part of the continental shelf that dips steeply to the seafloor

drill bit—a device used to cut through rock in search of oil and gas

drilling rig—a structure used in offshore oil drilling that supports drilling equipment and is either fixed to the seabed or floats independently

casing—a liner pipe or tube in water, oil, or gas wells

fossil fuels—a fuel made of the decayed remains of ancient plants and animals; includes coal, oil, and natural gas

impermeable—rock or soil that has very small pores that prevent water from passing through

mid-ocean ridge—an underwater mountain range that extends through the middle of most oceans; formed when forces within the Earth spread the seafloor apart, causing it to buckle

natural seepage—the escape of oil from permeable rock and soil that occurs without any assistance by man (naturally)

ocean trench—a deep trench in the ocean, caused when one piece of the seafloor is pushed beneath another piece

permeable—describes rock or soil that has connecting pores that allow water to pass through easily

pressure—the force acting on a surface divided by the area over which it acts

seamount—an underwater volcano

submersible—an underwater vessel, especially a small craft designed for use at deep levels

oil—petroleum, the crude product that is distilled and refined to produce a variety of industrial oils and oil-based products

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 3 of *The Case of the Ocean Odyssey*, discuss the previous segment to review the problem and assess 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 **Tools**. The **Problem Board** can also be found in the **Problem-Solving Tools** section of the latest online investigation. Have students use this section of the web site to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 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 previous segments. 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 2.
5. Read the overview for Segment 3 and have students add any questions to their list that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the **Educators** area of the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program so they will be able to 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. Teachers can print them from the **Educators** area of the web site ahead of time for students to copy into their science journals.

Careers

museum curator
petroleum engineer
marine geologist
seismic engineer
driller
tool pusher

View Segment 3 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 currents, tides, oil formation, oil production, and ocean floor topography. Organize the information, place it on the Problem Board, and determine whether any of the students' questions from the previous segments were answered.
4. Decide what additional information is needed for the tree house detectives to determine how the oily tennis shoes washed up on the Virginia shore. 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.
5. 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.
6. 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 1** – *Seepy Sandwich*

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 2003–2004 Season and click on *The Case of the Disappearing Dirt*. In the green box, click on **Activities/Worksheets**.

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

a. *Amphibious Vehicles*

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 Mysterious Red Light*. In the green box, click on **Download the Educator Guide**.

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

a. **Segment 3** – *The Three Little Volcanoes*

b. **Segment 3** – *The Ring of Fire*

7. If time did not permit you to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under After Viewing on page 15 and begin the PBL 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, PBL 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 found on the web site. Visit the **Research Rack** in the **Tree House** and find the online PBL investigation main menu section, **Problem-Solving Tools**, and the **Tools** section of the **Educators** area for more assessment ideas and tools.

Resources *(additional resources located on web site)*

Books

Berger, Melvin: *Oil Spill! Harper Collins Children's Books,* 1994, ISBN: 0064451216.

Borden, Louise: *Sea Clocks: The Story of Longitude*. Simon and Schuster Children's, 2004, ISBN: 0689842163.

Cole, Joanna: *The Magic School Bus on the Ocean Floor.* Scholastic, Inc., 1994, ISBN: 0590414313.

Collard, Sneed: *The Deep Sea Floor*. Charlesbridge Publishing, Inc., 2003, ISBN: 1570914028.

Gibbons, Gail: *Exploring the Deep Dark Sea*. Little, Brown Children's Books, 2002, ISBN: 0316755494.

Littlefield, Cindy: *Awesome Ocean Science*. Ideals Publications, 2002, ISBN: 1885593716.

Oleksy, Walter: *Mapping the Seas*. Scholastic Library, 2003, ISBN: 0531166341.

Scholastic: *Scholastic Atlas of Oceans*. Scholastic, Inc., 2004, ISBN: 0439561280.

Taylor, Leighton: *Atlantic Ocean*. Blackbirch Press, 1999, ISBN: 1567112463.

Vieria, Linda: *Seven Seas: Exploring the World Ocean*. Walker and Company, 2003, ISBN: 0802788335.

Video

Cousteau Productions: *Under the Waves, Exploring with Submarines, Vol. 2*
Grades K–5

Disney Channel: *Ocean Exploration (Bill Nye, the Science Guy)*
Grades 3–6

Discovery Channel: *The Blue Planet*
Grades 6–adult

Schlessinger Media: Oceans
Grades 5–8

Status: *Captain Jon Explores the Ocean*
Grades K–3

Web Sites

The Houston Museum of Natural Science
Visit this site to learn more about the Houston Museum of Natural Science in Houston, Texas. Be sure to visit the Hall of Energy exhibit.

http://www.hmns.org/

How Oil Drilling Works
Learn how oil is formed, how we find oil, how we drill and extract oil, and the parts of an oil well. There are also links for more information on oil drilling.

http://www.howstuffworks.com/oil-drilling.htm/printable

Offshore Energy Center's Ocean Star
Less than an hour from downtown Houston, the world's petroleum capital, the Offshore Energy Center (OEC) operates its state-of-the-art facility, the Ocean Star. Visitors step onboard, tour the completely refurbished jack-up drilling rig, absorb the day-to-day excitement of offshore drilling and production, marine transportation, environmental protection, construction, pipelining—all experienced through three decks of videos, equipment exhibits, and interactive displays. It's like a museum, educational attraction, and working drilling rig all rolled into one. Take a virtual tour while visiting the web site.

http://www.oceanstaroec.com/

BP Productions
Petroleum Energy
On this kid-centered web site, learn all about oil, where it comes from, how it's used, and how it affects the environment.

http://www.eia.doe.gov/kids/non-renewable/oil.html

The Ocean Floor
Brain POP's interactive web site for kids. Learn about the ocean floor through comics, movies, and activities. You must be a subscriber to complete more than two activities per day.

http://www.brainpop.com/science/earth/oceanfloor/index.weml

Dive and Discover: Expeditions to the Seafloor
This interactive distance learning Web site immerses you in the excitement of discovery and exploration of the deep seafloor. Dive and Discover brings you right onboard a series of research cruises to the Pacific and Indian Oceans and gives you access to the latest oceanographic and deep submergence research as it happens!

http://science.whoi.edu/DiveDiscover/

Oceans Alive! Looking at the Sea
Visit this site to learn about the topography of the ocean floor, how the ocean changes over time, the water cycle, and the four oceans of the world.

http://www.mos.org/oceans/planet/index.html

Physiography of the Ocean Basins
This site acquaints visitors with the topography of the ocean basins, the ocean basin configuration, and has some good illustrations to support the ideas.

http://www.physicalgeography.net/fundamentals/10p.html

Smithsonian—Ocean Planet: How Deep Can They Go?
On this interactive web site, learn about the different depths of the ocean and at which of the various depths animals can live.

http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_how_deep.html

Plate Tectonics
Brain POP's interactive web site for kids. Learn about plate tectonics through comics, movies, and activities. You must be a subscriber to complete more than two activities per day.

http://www.brainpop.com/science/earth/platetectonics/index.weml?&tried_cookie=true

Virginia Institute of Marine Science
The Virginia Institute of Marine Science (VIMS) has a three-part mission to conduct interdisciplinary research in coastal ocean and estuarine science, educate students and citizens, and provide advisory service to policy makers, industry, and the public. The VIMS School of Marine Science (SMS) is the professional graduate school in marine science for the College of William & Mary.

http://www.vims.edu/

National Ocean Industries Association
Visit this web site for a great activity book about oceans and energy—great for kids to use and learn more about ocean oil rigs.

http://www.need.org/needpdf/activitybook.pdf

Activities and Worksheets

Density Stackers

Segment 3

Purpose

To learn about density

Background

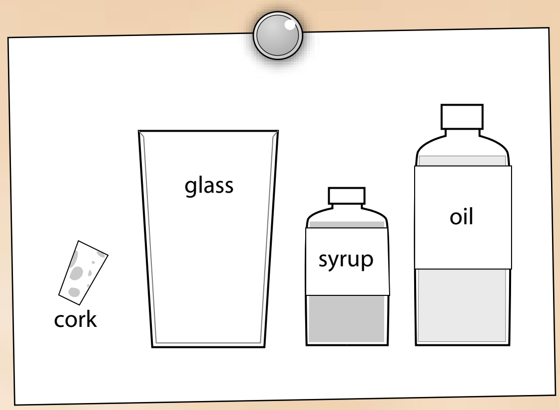
Density is the amount of mass an object has compared to its volume. Different liquids have different densities. A liquid of lesser density will rest on top of a liquid of greater density. Consider a bottle of salad oil dressing. If you look at the bottled dressing, you will see that the different density levels of the liquids cause different layers to form. If you shake up the salad oil, it will scatter the layers, but the liquids will never fully combine. In time, the liquids in the salad oil will separate again to form density layers. Different objects have different densities as well. When placed in liquids, the objects will "layer" themselves in the order of their own densities. Ocean waters also have various density layers. Colder water is denser and is usually found below warmer water. Saltwater is denser and is usually below freshwater.

Materials

80-mL syrup
1 glass jar
80-mL cooking oil
80-mL water
measuring cup
1 small piece of plastic
1 grape
1 small cork
science journal

Procedure

1. Pour 80 mL of syrup into a glass jar.
2. Add 80 mL of cooking oil to the jar.
3. Observe the liquids and record your observations in your science journal.
4. Add 80 mL of water to the jar.
5. Observe the liquids and record.
6. Drop a piece of plastic in the jar.
7. Observe the location of the plastic and record. Illustrate.
8. Drop a grape in the jar.
9. Observe the location of the grape and record. Illustrate.
10. Drop a cork in the jar.
11. Observe the location of the cork and record. Illustrate.
12. Write an explanation of your observations.



Conclusion

1. What happened when you poured each liquid into the jar? Why?
2. Did the objects (plastic, grape, and cork) all rest in the same place? Why or why not?
3. Describe how this experiment explains density.
4. Explain why it is important to understand density when cleaning up an oil spill.

Extension

1. Predict what will happen if you mix the layers. Stir the mixture and observe what happens. Predict what will happen to the layers after a few hours. Let the mixture sit undisturbed for 2 hours and then observe. Repeat this experiment with different liquids and different objects. Do the results vary? Why or why not?
2. Fill an aquarium two-thirds full of room temperature water. Acquire several brands of full soda cans. Predict which soda cans will sink or float. Test your hypothesis. Perform research to better understand why some brands of soda floated while others sank.

Texas Tea, Black Gold

Segment 3

Purpose

To learn the difficulties involved in drilling for oil

Background

Both oil and natural gas form over millions of years from the decaying of tiny organisms in the ocean. The process begins when plankton organisms die, fall to the seafloor, and pile up. Later, sediment is deposited over them, and they are compacted by the weight. This pressure on the organic matter helps chemical reactions occur, creating the liquid we call oil, as well as the gases we call natural gas. As oil and natural gas migrate toward the surface, an impermeable layer of rock, such as shale, may stop their movement. When this rock traps the oil or natural gas below it, a reservoir of oil or gas forms.

The question is how to find these reservoirs. Have you ever tried to get dressed in the dark? Imagine trying to find a matched pair of socks without being able to look at them first. Chances are, you probably would not get a matched pair on your first try. You would have to try several times before you were successful. Drilling for oil is a lot like that. Because the oil is under the ground, it is difficult to know exactly where to find it. Geologists and engineers study the geology of the Earth and usually have a general idea where oil might be located, but it may take several drilling attempts before they actually find it.

Materials

- 1 piece of 15-cm X 15-cm foam board
- 4 sharpened pencils
- 2 clear plastic straws
- 37.85-L (10-gallon) aquarium
- 300 mL (300 cubic centimeters) of dark sand
- 1 large bag of light sand
- clear tape
- water
- metric ruler
- science journal

Teacher Prep

1. For each aquarium, pour the dark sand in 3 equal mounds.
2. Cover the bottom of the aquarium and the mounds of dark sand with the light sand to a depth of 6 centimeters (cm). See diagram 1.
3. Trying not to disturb the sand, fill the aquarium with water to a depth of 20 cm.
4. WITH ADULT HELP, use a sharp knife to cut a 2-cm hole in the middle of each foam board.

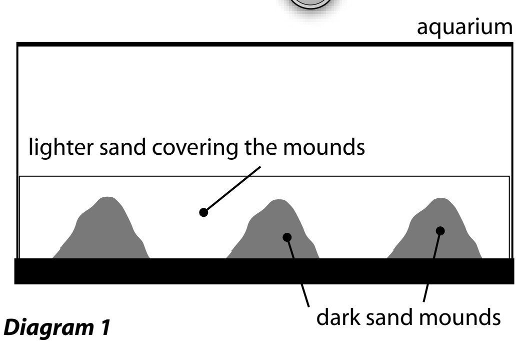


Diagram 1

Procedure

1. Insert a sharpened pencil into each of the 4 corners of the foam board. The pencils represent the legs of an oil rig. See diagram 2.
2. Carefully place the oil rig in the water.
3. The deck (foam board) of the oil rig should be slightly above the water.
4. Tape 2 straws together end to end, making sure to completely seal the connection.
5. Use masking tape or string to create a 6-sided, equal quadrant grid on top of the aquarium tank. See diagram 3 on page 53.
6. Label the quadrants A, B, C, D, E, and F.
7. In your science journal, draw and label the grid.
8. Using the straws as a drill, try to strike oil.
   a. Insert the straw into the hole of the deck and into the sand until it hits the bottom of the aquarium.
   b. Cover the end of the straw with your finger.
   c. Remove the straw, still holding the end of the straw with your finger.
   d. If you have dark sand in your straw, you struck oil!
   e. Record the letter of the grid in which you drilled for oil and your findings. Place a small dot in your grid diagram to mark the approximate spot you drilled.
   f. Continue drilling for "oil" and recording your findings.

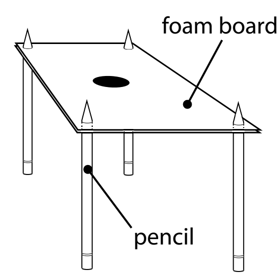


Diagram 2

Texas Tea, Black Gold

Segment 3

Conclusion

1. Was it helpful to mark the location of each well you drilled? Why or why not?
2. If you were to repeat the activity, what would you do differently?
3. How do think drilling companies track each hole that's drilled?

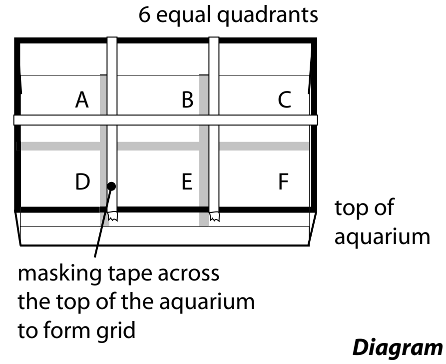


Diagram 3

Extensions

1. Research oil exploration careers such as petroleum engineer, geologist, roustabout, roughneck, derrick man, driller, and tool pusher. Write a job description and include the salary range for each. Present your findings to the class. Tell which job you might someday apply for (if any).
2. Choose one of the careers and write a story depicting what a typical day would be like in that job. Give a presentation to the class as if you held that job.

Building a Rig

Segment 3

Purpose

To learn about various types of oil drilling platforms

Background

There are four general types of offshore oil rigs, semi-submersible, platform, jack-up, and drill ship.

- A semi-submersible rig is a floating, drilling unit with pontoons and columns, which, when flooded with seawater, cause the pontoons to submerge to a predetermined depth. Although wave action moves the rig, it floats low in the water, with a large part of its structure underwater. It is very stable and the preferred choice for exploring deep water wells.
- A platform rig is an immobile (stationary) structure made of concrete and steel. When oil or gas is located, a platform rig can be constructed to drill more wells. Barges float the platform rig to the location and then lower it to the seabed. Its legs are then flooded and anchored to the seabed. This type of oil rig is used in shallow water.
- A jack-up rig is a mobile structure but instead of floating over the drilling location, it has long leg structures that lower to and into the seabed, raising the rig out of the water. The maximum depth for operation is 500 feet.
- A drill ship is a vessel shaped like a ship that uses computers to maintain its position over a drill hole. This type rig is not as stable as semi-submersibles, but it can drill in very deep water.

Materials

2 pieces of 15-cm X 15-cm foam board
aquarium from Texas Tea, Black Gold (p. 52)
water
toothpicks
modeling clay
4 small empty glue bottles with twist-close tops
4 pieces of string or yarn, each 45 cm long
8 small weights (sinkers)
metric ruler
science journal

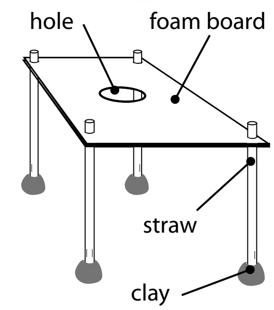


Diagram 1

Teacher Prep

1. Follow the directions in Texas Tea, Black Gold (p. 52) to set up an aquarium. If the aquarium was previously built, remove the grid.
2. Using a sharp knife, cut a 2-cm hole in the middle of each foam board.
3. In one of the foam boards, cut 4 holes in the corners large enough for a straw to fit through.
4. For each student, cut two 1-cm slits 2–3 cm from the bottom of 4 straws.
5. Cut 2 small holes near the bottom of each empty glue bottle.
6. Cut 4 holes in the corners of the last foam board big enough for the necks of the glue bottles to fit (without the caps).

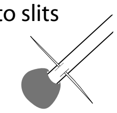


Diagram 2

Procedure

Platform Rig

1. Adjust the water level in the aquarium so that it is 15 cm deep.
2. Carefully examine the 4 straws and note the slits on one end.
3. Slide the un-slit end of the straws through the foam board with the 4 holes (1 in each corner).
4. Use clay molded into square "feet" to seal the bottoms of each straw. See diagram 1.
5. Using a small amount of clay, seal the top of each straw.
6. To represent opening the valves of the oil rig legs, insert toothpicks into the slits to hold them open. See diagram 2.
7. Float the platform in the aquarium.
8. Use a toothpick to break the seal of the clay at the top of the straws so that the air in the straw can escape.
9. Observe and record what happens to the rig as the straws fill with water.
10. Optional: Use a straw to drill for oil. See Texas Tea, Black Gold (p. 52).

Building a Rig

Segment 3

Semi-Submersible Rig

1. Add water to the aquarium so that the water depth is 20 cm.
2. Thread a piece of string through the holes in each empty glue bottle. Make sure the string hangs evenly.
3. Attach the weights to the ends of the strings. See diagram 3.
4. Remove the tops of the glue bottles.
5. In the other foam board, insert a glue bottle through each of the four holes.
6. Replace the tops of the glue bottles and close them tightly. See diagram 4.
7. Place the floating oil rig in the water.
8. Spread out the weights on the bottom of the aquarium and secure the rig. Note: If the weights don't reach the bottom, adjust the water level of the aquarium.
9. Open the tops of the glue bottles.
10. Observe and record what happens to the oil rig.
11. Optional: Use a straw to drill for oil. See Texas Tea, Black Gold (p. 52).

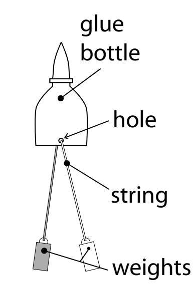


Diagram3

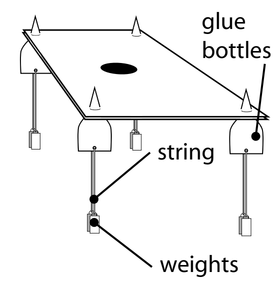


Diagram 4

Conclusion

1. What are some of the challenges faced by people who drill for oil?
2. What happened to the stationary oil rig as the straws filled with water? What problems might this situation pose for people trying to drill for oil?
3. What happened to the floating oil rig when you opened the glue bottle caps?
4. Which oil rig do you think is the easiest to use?

Extension

1. Visit **http://papertoys.com/rig.htm** to download and print a copy of a paper model of a jack-up oil rig. *(Consists of four pages with instructions on how to assemble the rig.)*
2. Make an edible oil drill! Mix batter for white, yellow, and chocolate cake mixes. Make cupcakes with layers of each flavored batter to represent rock layers. In each layer, hide chocolate-covered candies to represent oil deposits. After the cupcakes are baked, use a clear straw to drill for oil. If there is melted chocolate in your straw, you struck oil! Repeat several times. Enjoy the cupcake!
3. Research the various types of oil rigs. Choose one and build a model of it from materials found at home. Label the various parts and write a description of each and its use. Present your model to your group or class.

Seepy Seeps Seep Seepily

Segment 3

Purpose

To understand oil seeps

Background

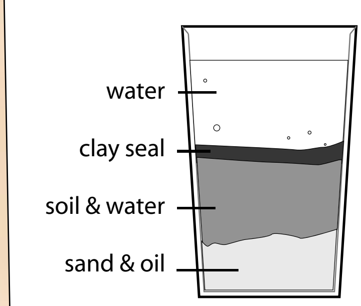
Millions of years ago, huge deposits of petroleum formed in ocean basins. As time went by, layers of sedimentary rock formed over the oil deposits, sealing the oil inside. Over time, earthquakes, erosion, and other natural phenomena have created cracks in the layers of rock. Some layers of rocks also have tiny holes throughout (are permeable). Because oil and natural gas are less dense than water, they migrate upward to get on top of water-saturated rock layers. The oil oozes through these cracks and holes. This natural oozing of oil is called a seep. The oil rises through the water to the surface where it congeals into floating globules of sticky tar, which is carried by ocean currents and can sometimes end up on beaches around the world. For hundreds of years, people have been using naturally seeping oil to waterproof various items. Natural seepage accounts for approximately 62 million gallons of oil being added to the ocean each year. Some oil companies have even built devices to "catch" some of the natural seepage for commercial use.

Materials

- 1 large, clear glass
- 1 small mixing bowl
- 2-mL cooking oil
- 10-mL (or 10-cm^3 – cubic centimeters) sand
- 30-mL (or 30-cm^3 – cubic centimeters) soil
- 1 piece modeling clay
- water
- measuring cup
- science journal
- stopwatch or clock with second hand

Procedure

1. In your group, discuss oil seeps and in your own words, write a definition of seepage.
2. Pour the sand into the bottom of the glass.
3. Pour the oil onto the sand.
4. Add 1 mL of water to the oil in the glass.
5. In a mixing bowl, mix the soil with water until the soil is very wet.
6. Pack the soil and water mixture into the glass, making sure it is tightly packed.
7. Make a prediction of how long it will take for the oil to seep into the water. Record your prediction in your science journal.
8. Flatten and mold the clay into a circle the same size as the circumference of the glass.
9. Place the clay in the glass, creating a thin seal over the soil.
10. Fill the glass with water.
11. Start the stopwatch.
12. Observe the oil and time how long it takes the oil to seep through the layers to the top of the water.
13. Record your observations and time.
14. Share your data with the class and create a class chart of each group's data. Create a graph depicting the data.
15. Find the average time it took for the oil to seep to the top of the water.
16. If times were different among the groups, discuss why and talk about the factors that could make the oil seep at different intervals.



Seepy Seeps Seep Seepily

Segment 3

Conclusion

1. How long did it take for the oil to begin seeping to the top of the water?
2. How long do you think it would take for all the oil to seep to the top of the water?
3. If the clay seal were not tight, how would the oil seep be affected? Why?
4. What do you think would happen if you used saltwater instead of freshwater?
5. In the program, Ms. Mislesis told Kali that divers have described seepage areas as a bunch of gopher holes. Write a short story that describes a dive adventure of your own and tell what you might see in an oil seepage area.

Extension

1. Allow time to observe the experiment until all the oil has seeped to the top of the water. How long did it take?
2. Repeat the same experiment, replacing the freshwater with saltwater. Did using saltwater make a difference?
3. Using a taller glass, repeat the experiment. Did the height of the glass make a difference in the time it took for the oil to begin seeping? Why or why not?
4. Repeat the experiment, but use a toothpick to create "vents" (holes) in the clay.

Read All About It!

Segment 3

Choose one

1. Research the various uses of oil and natural gas in our everyday lives. Research the environmental consequences of drilling for oil and gas. Decide whether you are in favor of or against continued oil exploration. Write a letter to the editor explaining your viewpoint.
2. Create a cartoon to illustrate the pros or cons of oil exploration.
3. Research renewable energy sources and choose one to give as a report to the class. Explain why renewable energy sources are a must for the future.
4. Create a poster or collage showing the various ways that oil and the products made from oil have improved the quality of our lives.

EXTRA! EXTRA!
READ ALL ABOUT IT!

Pressing Pressure

Segment 3

Purpose

To compare water pressure at different depths

Background

Have you ever tried to swim to the bottom of a pool? Did you feel a squeezing in your head and ears? This squeezing sensation is a result of water pressure, which is a function of weight that is related to depth. Water pressure increases with depth. Density also affects water pressure and is related to weight. The greater the density of water, the greater the pressure it exerts. Saltwater is denser than freshwater because of the salt and dissolved minerals in it; therefore, if you are diving in freshwater to a 3-m depth, you will feel less pressure than if you dived 3 m deep in saltwater.

Materials

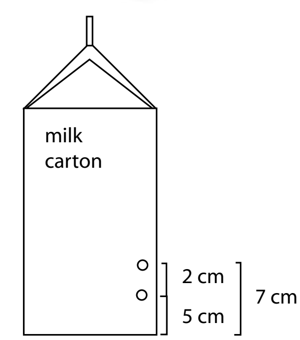
cup
1.9 L (1/2 gallon) milk carton – not plastic
946.36-mL (1 quart) milk carton – not plastic
pencil
masking tape
deep pan
water
metric ruler
science journal
access to a sink or outside

Teacher/Adult Note

Use a pencil to make 2 identical holes in both milk cartons. One hole should be about 5 cm from the bottom. The other hole should be about 7 cm above the first hole.

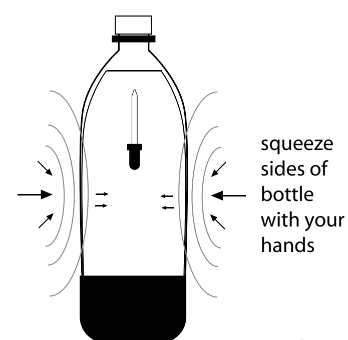
Procedure

1. On each carton, tape over the holes with one long strip of masking tape.
2. Place the 1.9 L carton in the deep pan.
3. Fill the carton with water.
4. Remove the tape.
5. Observe the flow of water through the holes.
6. Record your observations in your science journal.
7. Empty the pan.
8. Place the 946.36-mL carton in the empty, deep pan.
9. Fill the carton with water.
10. Remove the tape.
11. Observe the flow of water through the holes.
12. Record your observation in your science journal.



Conclusion

1. Which hole, top or bottom, squirted farthest? Why?
2. Was there a difference between the large and small carton? Why or why not?
3. Does volume affect water pressure? Depth? Why or why not?
4. How might increased water pressure affect deep-sea exploration? Aquatic life?



Extension

Extension

1. Repeat the activity but this time add a few more holes to the carton. Is there a difference in water flow through the holes? Record your observations in your science journal.
2. Repeat the activity with saltwater. Did it make a difference in the water flow through the holes? Why or why not?
3. Fill a 2-L soda bottle with water until it is almost completely full. Partially fill an eyedropper with water. Put the eyedropper in the bottle of water. If the dropper sinks, remove it and squeeze some of the water out. Once the dropper floats, close the bottle lid tightly. Squeeze the sides of the bottle with your hands. Observe the water level inside the dropper. What happens to the water level inside the dropper? Why does the water level change? What does this activity have to do with pressure?

Submersibles and Marshmallows

Segment 3

Purpose

To understand the difficulty of ocean exploration by human beings

To realize that pressure increases as water depth increases

To learn how density affects submersibles

Materials

1 plastic soda bottle
1 balloon
91 cm of rubber tubing
tape
rubber bands
scissors
1 nail
coins
large basin, sink, or inflatable pool
tap water
1 large marshmallow
1 glass bottle (with an opening large enough for the marshmallow to fit)
flexible straws
modeling clay
science journal
pen

Background

Water pressure in the ocean is one of the many factors that oceanographers encounter when exploring the ocean depths. The ocean is very deep in places. The average ocean depth is about 3,800 meters. The greatest ocean depth is over 11,000 meters. The pressure at any depth in the ocean is caused by the weight of the overlying water. The deeper you go in the ocean, the greater the pressure. Pressure is usually expressed in atmospheres. One atmosphere is equal to the weight of the Earth's atmosphere at sea level, or about 1.03 kilograms per square centimeter. So if you are at sea level, every square centimeter of your body surface is subjected to a force of 1.03 kilograms. The pressure increases about 1 atmosphere for every 10 meters of water depth. At 5,000 meters below the surface, the pressure would be approximately 500 atmospheres, or 500 times greater than the pressure at sea level.

Human beings cannot travel to the ocean depths unaided. We use a device called the Self-Contained Underwater Breathing Apparatus (scuba), to help us go to extreme depths. Even though technological advances keep making it possible to dive deeper, there are severe restrictions on the depth and length of time that divers can spend underwater. Aquatic research often requires diving to depths beyond 40 meters—depths that exceed the limits of conventional scuba equipment. However, divers can extend their bottom time by breathing nitrox, a mixture of oxygen-enriched air. Even when using nitrox, the weather, the gas supply in their tanks, and the risk of decompression sickness, commonly known as "the bends," still limit divers' capabilities and time spent underwater.

To go deeper, we must use other devices such as remotely operated vehicles (ROVs) and submersibles. These vehicles are designed to handle the enormous pressure of the ocean depths. These vehicles have reinforced walls to withstand the pressure. Some aquatic animals can live at deep ocean depths. Sperm whales can dive 2,250 meters deep. Scientists are studying deep dwelling animals to find out how they can withstand such great pressure.

Teacher Prep

Use the scissors to make 6 holes across the top of the bottle and 6 holes across the bottom. Use a nail to punch a hole in the bottle cap large enough for the tubing to fit through. Note: Tape flexible straws together and use as a substitute for the tubing. Stretch the balloon before attaching it to the tubing.

Procedure

Soda Bottle Sub

1. Attach a balloon to the end of the rubber tubing with the rubber band. See diagram 1.
2. Put the balloon in the plastic bottle.
3. Put the other end of the tubing through the bottle cap. See diagram 2 (p. 61).
4. Screw the bottle cap onto the bottle.
5. Attach a few rubber bands around the bottle.
6. Slide some coins underneath the rubber bands. See diagram 3 (p. 61). Now you have a soda bottle sub!
7. Fill the basin 1/2 full with water.

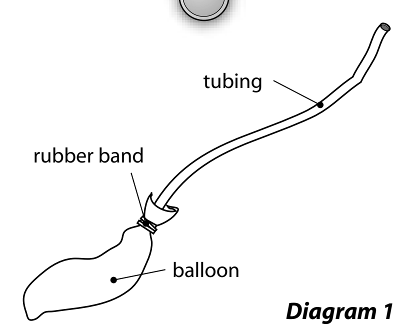


Diagram 1

Submersibles and Marshmallows

Segment 3

8. Place your sub in the water.
9. Blow into the tubing until the balloon inflates.
10. Hold your finger over the end of the tube to keep the air in the balloon.
11. Rearrange the coins around your sub so that the sub floats evenly.
12. Slowly take your finger off the tube and allow the air to escape.
13. Observe what happens to your sub.
14. Blow air back into the tube to fill the balloon again.
15. Observe what happens to your sub.
16. Record your observations in your science journal.

Pressure Marshmallows

17. Use a pen or marker to draw a face on one of the flat ends of your marshmallow.
18. Put the marshmallow into a glass bottle.
19. Wrap the modeling clay about 2.5 cm from the end of a straw. The clay should make a ring around the straw. See diagram 4.
20. Put the short end of the straw into the bottle. The clay should prevent the straw from dropping farther into the bottle.
21. Press the clay around the mouth of the bottle to completely seal it. No air should be able to get in or out.
22. Using the straw, suck air out of the bottle. Fix any leaks in the clay.
23. Have your partner observe what happens to the marshmallow as the air is removed.
24. Replace the used straw with a clean one and have your partner suck out the air while you observe.
25. Record your observations in your science journal.

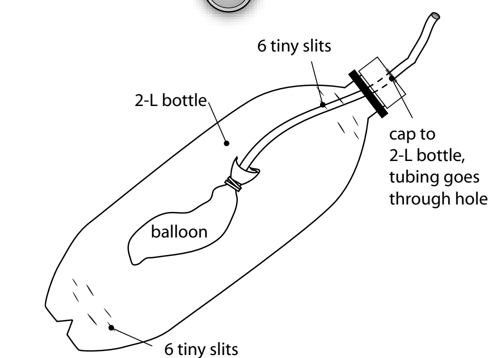


Diagram 2

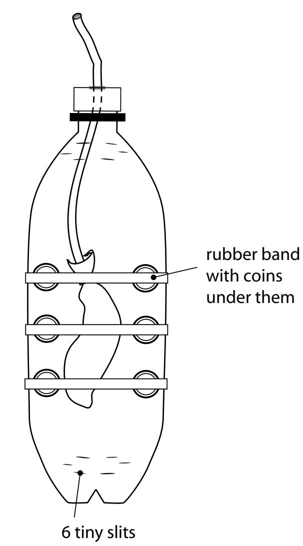


Diagram 3

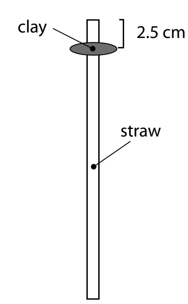


Diagram 4

Conclusion

1. What happened to the sub when you blew air into the balloon? Let air out?
2. Why did the sub submerge and resurface?
3. What does density have to do with the movement of the sub?
4. What happened to the marshmallow when the air was removed? When the air was returned?
5. Why did the marshmallow change shape?
6. What does the marshmallow activity tell you about ocean pressure?

Extension

1. Research to find out the various submersibles used for deep-sea exploration both in the present and in the past. Create a time line to show the technological advancements in deep-sea exploration.
2. Design your own ROV like Dr. D and test it in a tub of water.

Answer Key

Segment 3

Density Stackers

1. The liquids separated and did not mix because they had different densities.
2. The objects all rested in different location because their densities were different.
3. Different liquids have different densities and so do different objects. The denser items will sink under the less dense items.
4. Oil is less dense than water. During an oil spill, the oil will initially float on the surface. Oil slicks on the surface of the water are more easily seen and contained than denser oil that sinks to the bottom. However, wave action, stormy weather, and other factors can begin to break the oil slick apart, wash it onto beaches, and slowly cause oil to sink to the bottom.

Texas Tea, Black Gold

1. Answers will vary, but students should have found the grid useful because it helped them better organize their search for oil and keep track of previously drilled areas.
2. Answers will vary.
3. Answers will vary but might include global positioning systems (GPS), detailed ocean floor maps, and so on.

Building a Rig

1. Answers will vary.
2. The stationary rig sank and anchored itself to the bottom. The rig can no longer move freely. If oil is not at the anchored location, it will have to be moved again.
3. The glue bottles sank and brought the foam board down as well.
4. Answers will vary.

Seepy Seeps Seep Seepily

1. Answers will vary.
2. Answers will vary.
3. Oil would leak through the sides of the clay because there would be no seal to hold the oil under the clay.
4. Answers will vary.

Pressing Pressure

1. The bottom hole should have squirted the farthest because the greater the depth, the greater the pressure. The more pressure, the farther the water will go.
2. There should not have been a difference in the two containers because depth, not volume, affects water pressure.
3. No. Volume does not affect water pressure. Yes. Depth does affect water pressure. Pressure is a function of weight. It is the amount of weight pushing down on an object from above, not from the sides.
4. Increased water pressure means deep-sea explorations have to have equipment strong enough to withstand the pressure. Aquatic life at these depths must adapt to the high levels of pressure to survive.

Submersibles and Marshmallows

1. When air was blown into the balloon, the sub rose to the surface. When the air was let out, the sub sank.
2. The sub changed its density as it took in and released air and allowed the sub to submerge and to resurface.
3. When the sub was denser than the water, it sank. When the sub was less dense than water, it floated.
4. When the air was removed from the bottle, the marshmallow expanded. When the air was returned to the bottle, the marshmallow returned to its original shape.
5. The marshmallow changed shape because the pressure inside the bottle changed. When the air was removed, the pressure in the bottle decreased, causing the marshmallow to expand. The marshmallow shrank back to its original size when the air was returned because the pressure increased.
6. The deeper you go in the ocean, the more the pressure increases. With enough pressure, objects will collapse.

On the Web

The Heavy Weight

1. The blue saltwater sank and the freshwater floated at the top.
2. The saltwater was denser because it sank.
3. The denser body of water will sink underneath the less dense body of water.
4. Saltwater is denser than freshwater. Water with less density will float on top of denser water.

The NASA SCI Files™

The Case of the Ocean Odyssey

Segment 4

The tree house detectives think they are almost ready to solve the mystery but become concerned over the environmental impact that the oil has on their community and wildlife. They dial-up a NASA SCI Files™ Kids' Club at Key Largo School in Key Largo, Florida, where members are conducting an experiment to learn more about cleaning up an oil spill. After discovering that cleaning up oil is not an easy job, RJ goes to NASA Wallops Flight Facility to talk with Ms. Sue Fields and Dr. John Moisan. Ms. Fields explains the environmental impact of oil, why it is so important to contain an oil spill before it reaches land, and who is responsible for the cleanup. Dr. Moisan helps the detectives put the final pieces together to solve the mystery as he explains coastal currents. Finally, it is off to Dr. D's lab where the tree house detectives wrap it up and get confirmation on their hypothesis. Another case solved!

Objectives

Students will

- understand convection currents.
- demonstrate the movement caused by dispersion.
- demonstrate the effectiveness of various methods of oil spill cleanup.
- identify the sources of oil pollution in the ocean.
- learn the difference between immiscible and miscible.
- learn how an oil spill affects sediment.
- explain the impact of oil pollution on the environment.
- learn about surface currents.

Vocabulary

absorbents—materials capable of soaking up liquids such as oil

boom—a floating barrier used to confine or restrict an oil spill

coastal currents—density or surface currents located along or near the coast, such as long-shore currents, rip tides, upwellings, and downwellings

dispersion—the scattering of something within an area or space

eddy—a movement in a flowing stream of liquid or gas in which the current doubles back to form a small whirl

EPA—The Environmental Protection Agency leads the nation's environmental science, research, and assessment efforts and works to develop and enforce regulations that implement environmental laws enacted by Congress.

filament—winding pieces of a flowing stream that separate from the current

skimmer—a bowl-shaped object or device used to skim oil from the surface of the water

tar balls—globs of thick, sticky, black oil

U.S. Coast Guard—a branch of the military service that enforces maritime laws, acts in marine emergencies, and maintains navigational aids in wartime to supplement the Navy operations.

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 4 of *The Case of the Ocean Odyssey*, discuss the previous segment to review the problem and 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 3 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 3. 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 3.
5. Read the overview for Segment 4 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 during the program to answer the questions. An icon will appear when the answer is near.

View Segment 4 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. At the end of Segment 4, lead students in a discussion of the Focus Questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to learn more about the future of space exploration. The following instructional tools located in the **Educators** area of the web site may aid in the discussion: **Experimental Inquiry Process Flowchart** and/or **Scientific Method Flowchart**.

Careers

ecologist
environmentalist
environmental engineer
marine science technician
pollution control technician
sailor

3. 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.
4. 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 3** – *One in a Million*
      b. **Segment 3** – *To Still Water*

   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 2003–2004 Season and click on *The Case of the Disappearing Dirt*. In the green box, click on **Download the Educator Guide**.

   a. In the Educator Guide you will find
      a. **Segment 4** – *Shifty Sand*
      b. **Segment 4** – *To Erode or To Deposit, That Is the Question*
5. Wrap up the featured online PBL investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Sample evaluation tools can be found in the **Educators** area of the web site under the main menu topic **Tools** by clicking on **Instructional Tools**.
6. Have students write in their journals what they have learned about oceans, currents, oil, and oil spills so they can share with a partner or the class.

Resources *(additional resources located on web site)*

Books

Cherry, Lynne: *A River Ran Wild: An Environmental History*. Harcourt, Brace, and Company, 2002, ISBN: 0152163727.

Day, Trevor: *Popular Science Datafiles: Ocean*. Silver Dolphin Books, 2001, ISBN: 1571454802.

D'Lacey, Chris: *Break in the Chain*. Crabtree Publishing, 2002, ISBN: 0778709779.

O'Neill, Michael Patrick: *Fishy Friends: A Journey Through the Coral Kingdom*. Batfish Books, 2003, ISBN: 0972865306.

Parker, Steve: *Eyewitness: Seashore.* DK Publishing, Inc., 2000, ISBN: 0789458268.

Parker, Steve: *Seashore: A BBC Fact Finders Book*. BBC Worldwide Americas, 1997, ISBN: 0563344113.

Pringle, Laurence: *Oil Spills, Volume 1*. Morrow, William, and Company, 1993, ISBN: 0688098614.

Smith, Roland: *Sea Otter Rescue, the Aftermath of an Oil Spill*. Puffin, 1999, ISBN: 014056621X.

Video

Discovery School: *Earth's Waters*
Grades 3–6

Discovery School: *Finite Oceans*
Grades 6–12

Schlessinger Media: *Clean Water*
Grades 4–adult

Warner Brothers Family: *Free Willy 2*
Grades 3–adult

Web Sites

The Exxon Valdez Oil Spill
This site is a comprehensive resource for information regarding the Exxon Valdez Oil Spill. You will find information ranging from the grounding of the vessel to the current status of Prince William Sound.

http://library.thinkquest.org/10867/

Oil Spills
NOAA's web site about oil spills. Learn what an oil spill is, how one is cleaned up, and see what activities you can do to learn more about oil spills. There are also links to other web sites about oil spills.

http://response.restoration.noaa.gov/kids/kids.html

Global Marine Oil Pollution Information Gateway
This web site is a collection from several agencies and organizations that work to prevent discharges of oils into the marine and coastal environment. The site also offers educational material and special activities for children and students. The overall purpose of these efforts is to make young people familiar with the marine environment, to teach them to care about it, and to understand the consequences of abusing it. Several of the educational web sites also contain practical experiments for students to learn about the behavior and effects of oil in the marine environment.

http://oils.gpa.unep.org/kids/kids.htm

United States Environmental Protection Agency
Visit this web site to learn about oil spill characteristics, how to clean up oil spills, oil spill responses, as well as seeing pictures and experiments you can try at home to learn more about oil spills.
http://www.epa.gov/oilspill/eduhome.htm

Marine Debris
Human beings not only pollute the ocean with oil, but also with trash. This web site has coloring activities for kids so they can learn how we can stop polluting the oceans.
http://www.yoto98.noaa.gov/books/debris/debris1.htm

Human Impact on Oceans
Visit this web site to learn about the impact human beings have on oceans—from oil spills, to dredging, to other forms of pollution.
http://www.eco-pros.com/humanimpact.htm

NASA Wallops Flight Facility
Established in 1945 under NASA's predecessor, the National Advisory Committee for Aeronautics (NACA), Wallops Flight Facility—one of the oldest launch sites in the world—is on Virginia's Eastern Shore. Our support of scientific research and orbital and suborbital payloads places us at the center of NASA's Space and Earth Sciences initiative.
http://www.wff.nasa.gov/index.html

Office of Naval Research: Oceanography
Visit this web site to learn about oceans in motion, including tides, currents, habitats, ocean life, ocean water, ocean regions, research vessels, and more.
http://www.onr.navy.mil/focus/ocean/default.htm

Activities and Worksheets

In the Guide

On the Web

Convection Currents
Learn how temperature creates convection currents.

Dispersing Dispersion

Segment 4

Purpose

To demonstrate the movement caused by dispersion

Background

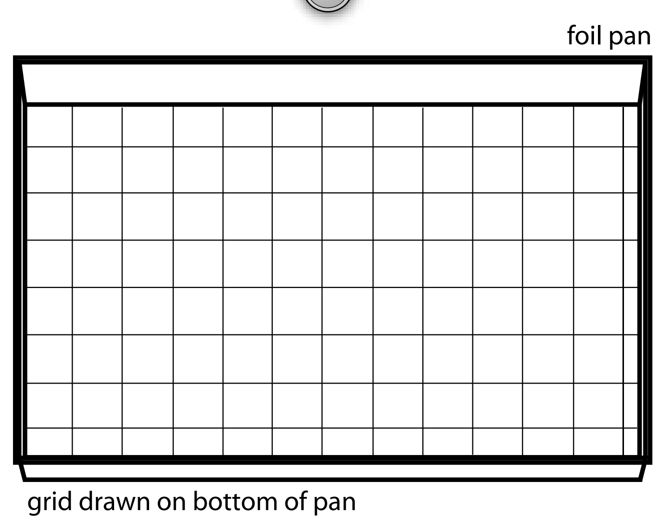
Dispersion is the random movement of objects. This movement is generated by things such as moving air or water molecules that bump into objects, causing them to begin moving randomly. Eventually, the objects will spread out in an even pattern.

Materials

permanent, waterproof marker
rectangular foil pan
tap water
8 small corks (or other small floating objects)
metric ruler
three different colored pencils
science journal

Procedure

1. Using the metric ruler and permanent marker, draw a grid on the inside bottom of the foil pan. Make sure the squares on the grid are approximately the same size.
2. Label each square with a grid coordinate (A1, A2, A3, B1, B2, B3, and so on)
3. Fill the pan with water.
4. Place the pan of water where it will be undisturbed.
5. Use the markers to label each cork.
6. Put the corks into the center of the pan of water.
7. In your science journal, draw and label a diagram of the grid in the pan.
8. Using colored pencils, show the location of each cork. *(Note: The corks should be in the center of the pan and more than one cork may be in the same square.)*
9. Predict where you will find the corks when you check the pan the next day.
10. Mark your predictions on the diagram in your science journal.
11. Allow the pan to sit undisturbed overnight.
12. Check the corks the following day.
13. Using a different color pencil, label the new positions of the corks.
14. In your own words, explain what happened to the corks.
15. Leave the corks and examine them again the next day.
16. Record your observations.



Dispersing Dispersion

Segment 4

Conclusion

1. What happened to the corks in the pan?
2. What caused the movement of the corks?
3. What is dispersion?
4. How can understanding dispersion help the tree house detectives learn more about where the tennis shoes came from?

Extension

On a piece of paper, make a grid so the squares are each at least 2.5 cm. Label each square on the grid with a coordinate pair. Hold a set of toy jacks in your hand above the center of the grid. Drop the jacks. On a sheet of graph paper, mark the location of the jacks with a dot. Be sure to label the x-axis and the y-axis on your graph. Now drop the jacks again. Mark the location of the jacks this time. This kind of diagram can show dispersion patterns. Draw a circle around the area on your graph where most of the jacks fell. The area inside your circle shows the average dispersion pattern for the jacks. Some of the jacks may have fallen far away from the others. The dots used to represent those jacks are called outliers because they don't follow the same general pattern as the others. These dots appear outside the circle. Now try dropping the jacks from a higher distance. Mark your results on the diagram. How do these results compare to the first two trials? What happened to the size of your dispersion pattern? Why do you think it happened?

Don't Be Crude!

Segment 4

Purpose

To demonstrate the effectiveness of various methods of oil spill cleanup

To understand what a difficult job oil spill cleanup is

Background

Each year millions of liters of oil enter the ocean. Although oil spills are relatively rare and account for only 5% of the total oil in the ocean, their effects on local wildlife and natural ecosystems can be catastrophic. Oil spill cleanup is affected by the type of oil, the source of the oil, the currents that flow in the area, and the condition of the water surface due to weather. Time is an important factor. The more an oil spill spreads, the more damage it can do and the harder it is to clean up. Immediately following an oil spill, attempts are made to contain the oil. Containment by booms, or barriers, keeps the oil from spreading. The use of log booms and floating booms with submerged skirts have been successful on a limited basis. Once the oil is contained, a variety of removal techniques have been used.

- Booms and skimmers contain the oil.
- The vacuum method is limited to calm water conditions.
- Absorbents such as straw, sawdust, peat moss, cornstarch may become waterlogged and difficult to remove and will present disposal problems.
- Absorbents such as synthetics absorb oil, but not water, and again present disposal problems.
- Burning leaves toxic residue and pollutes air.
- Newer types of chemical dispersants have greater effectiveness and less toxicity and are designed for very specific uses; they may include gelling agents, emulsifiers, or the use of bacteria to break up the oil.
- Sinking agents, such as sand, clay, or cement are PROHIBITED in U.S. waters; they sink to the bottom of the seafloor and affect sea life at these levels; natural breakdown of oil is slowed down considerably at these depths, causing longer term problems.

No current cleanup method is totally successful, but new satellite technology enables us to track the movement of the oil, the currents, and hazardous ocean conditions that can lead to spills.

Materials

(for each group of students)

- 1 disposable aluminum pie pan
- water
- blue food coloring
- metric measuring spoons
- 45-mL vegetable oil
- 30-mL pure cocoa powder
- 5-mL table salt
- cup for mixing
- a variety of absorbent materials such as cotton balls, paper towels, sponges, nylon stockings, or shredded wheat
- aluminum foil
- foam cups
- newspapers
- a few drops of dishwashing liquid
- wooden craft sticks for stirring
- tweezers or tongs

Don't Be Crude!

Segment 4

Procedure

1. Fill an aluminum pie pan half full of tap water.
2. Stir in 5 mL of table salt.
3. Add 3 or 4 drops of blue food coloring.
4. Mix well with a wooden stirring stick.
5. Let the solution settle.
6. In a cup, mix together 45 mL of vegetable oil and 30 mL of cocoa powder.
7. Stir until well blended. (This mixture represents your crude oil.)
8. Very slowly pour the simulated crude oil onto the top of the pan of water.
9. Observe what happens over the next few minutes.
10. Record your observations in your science journal.
11. Include a diagram that shows the oil spill.
12. Using the chart of oil spill terms, identify the types of oil spills you see.
13. Label your diagram.
14. Your job is to clean up the oil spill.
15. Choose any three of the absorbent materials listed above.
16. Attempt to clean up the oil spill by using the materials you have selected.
17. Place a small sample of one of these materials in the center of the oil spill.
18. Use tweezers or tongs to remove the absorbent material.
19. Using the cleanup chart, record what happens to the material and to the oil spill.
20. Estimate the percent of the oil that was cleaned up by your absorbent material.
21. Try a different absorbent material.
22. Compare the results of this material to the first one you used.
23. Now try adding two drops of dishwashing liquid to your oil spill.
24. Watch quickly to see what happens.
25. Record what you see.
26. You may want to once again try using one or more of the absorbent materials after you have added the detergent.
27. Compare the performance of these materials now to how well they worked when you first used them.
28. Try making a scoop from aluminum foil or from a foam cup.
29. Use the scoop to try to clean up the remainder of the oil spill.
30. Be sure to clean off the scoop after each dip in the water so you do not re-contaminate the water.
31. When you have cleaned up as much of the oil spill as possible, carefully dispose of your materials.

Don't Be Crude!

Segment 4

Conclusion

1. Under what conditions is a boom the most effective way to control an oil spill?
2. How effective were the absorbent materials you chose?
3. What does the absorbent material pick up?
4. How would you pick up the oil-contaminated material in a real oil spill?
5. What would you do with the contaminated materials after they were collected?
6. What impact did the dishwashing liquid have on the oil spill?
7. How effective were your original materials after the dishwashing liquid had been added to the water?
8. What effect might chemical absorbents (like the detergent) have on the ocean environment?
9. What was the most effective way to clean up the oil spill?
10. What are some other factors that might affect the cleanup of an oil spill?

Extension

Try this experiment again using freshwater instead of saltwater in the pan. What differences did you see? Try putting sand on the bottom of your "ocean." What happens to the sand when the contaminants are spilled? Explain why the United States prohibits the use of sinking agents, such as sand, clay, or cement, as ways to clean up oil spills. Do an Internet search to find pictures of oil spills. How do these pictures compare to the oil spill you created?

Glossary of Terms Used To Describe Oil Spills

- Spill characteristics will appear different under low light or strong wind conditions.
- light sheen: a light, almost transparent layer of oil
- silver sheen: a slightly thicker layer of oil that appears silvery or shimmery
- rainbow sheen: a sheen that reflects colors like a rainbow
- brown oil: a 0.1-mm–1.0-mm thick layer of small oil globules in suspension; although thickness may vary, can have a heavy or dull-colored sheen
- mousse: small oil globules in suspension that form as the oil weathers; colors can range from orange or tan to dark brown
- black oil: black colored oil that sometimes has a latex texture
- windows/streaks/stringers/fingers: oil or sheen arranged in lines or streaks
- tar balls: weathered oil that has formed a pliable (or easily shaped) ball; size varies from the size of a pinhead to about 30 cm; sheen may or may not be present
- tar mats: nonfloating mats of oily debris (usually sediment and/or plant matter) that are found on beaches or just offshore
- pancakes: isolated patches of oil shaped in a mostly circular design; range in size from a few meters across to hundreds of meters in diameter; sheen may or may not be present

Don't Be Crude!

Segment 4

Data Sheet for "Don't Be Crude" Observations

Record your observations for each type of material used to clean up the oil spill.

Material	Estimated Oil Cleaned Up (percent)	Comments (i.e.,: not very effective, effective, left with oily cotton, and so on.)
Absorbent 1:		
Absorbent 2:		
Absorbent 3:		
Dishwashing Liquid		
Absorbent 1:		
Absorbent 2:		
Absorbent 3:		
Skimmer		

Graphically Speaking

Segment 4

Materials

colored pencils
graph paper
Oil Spill Fact Sheet (p. 74)
world map

Purpose

To organize data into circle or bar graphs

To identify the sources of oil pollution in the ocean

Background

When a major oil spill occurs in the United States, teams of local, state, and national personnel work together to contain the spill, clean it up, and minimize the damage to human beings and the environment. Time is a critical factor when dealing with an oil spill. Without careful planning and clear organization, efforts to deal with large oil spills could be slow and ineffective. In the United States, the system for organizing responses to major oil spills is called the National Response System. In 1967, an oil tanker ran aground 15 miles off Land's End, England, spilling 33 million gallons of crude oil into the ocean. The spill had negative impacts on beaches, wildlife, fishing, and tourism as it destroyed 150 miles of coastline in France and England. Recognizing the possibility of a similar spill in the United States, the federal government sent a team of representatives from different federal agencies to Europe to observe the cleanup activities. Based on what the team learned from this spill, a National Contingency Plan (NCP) was developed and signed into law. As part of this law, the National Response System was formed. The National Response Center in Washington, DC, is the first agency to be notified when a major oil spill occurs. The center is staffed by officers and marine science technicians from the U.S. Coast Guard and serves as the national communications center to record oil spill reports and oversee oil cleanup.

Oceans suffer from far more than an occasional devastating spill. Disasters make headlines, but hundreds of millions of gallons of oil quietly end up in the seas every year, mostly from non-accidental sources. Natural seeps, oil runoff from municipal and industrial waste, and even air pollution contribute to the oil pollution found in the ocean.

Procedure

1. You are a marine science technician on the National Response System Team.
2. Examine the data that have been given to you about the source of oil pollution in the ocean waters.
3. Find the total number of gallons of oil that find their way into the oceans each year.
4. Find the percent that each source contributes to oil pollution. To find the percent, remember to divide the number of gallons from a specific source by the total number of gallons of oil.
5. Organize the data into a circle graph to show how much of the total oil pollution comes from each source.
6. Now organize the data about reported oil spills.
7. Make a bar graph to show how much oil spilled into the ocean during each accident.
8. On a world map, mark the location of the major oil spills listed in your Oil Fact Sheet.

Conclusion

1. Why is it important to maintain records about oil spills?
2. Which oil source is responsible for the largest percent of oil pollution in the ocean?
3. Which source contributes the least amount of oil to the pollution problem?
4. What steps can we take to prevent future oil spills?

Extension

Research the structure of an oil tanker. Design a model of a tanker. Pretend you are a worker on an oil tanker. Keep a journal to record your adventures, including the oil spill in which you are involved. Tell about your journey across the ocean and how the National Response Team begins the cleanup process.

Graphically Speaking

OIL SPILL
FACT SHEET

SOURCES OF OIL POLLUTION

Major Oil Spills – 37 million gallons

Oil from major tanker accidents accounts for a small percentage of the total oil pollution in the oceans. These spills, however, are often dramatic and can disrupt sea and shore life for miles.

Runoff – 363 million gallons

Used engine oil often finds its way into our oceans. Much oil from land and municipal waste becomes runoff that contaminates waterways and eventually ends up in the ocean. As cars drive over roads, oil may drip from the engines onto the pavement. Sealants used to coat blacktop roads are also oil-based products. When rainwater falls on these oily roads, the oil is washed away. Oily road runoff from a city of 5 million people could contain as much oil as one large tanker spill.

Routine Maintenance – 137 million gallons

Every year bilge cleaning and other ship operations release millions of gallons of oil into ocean waters. Most of these discharges are just a few gallons each.

Air Pollution – 92 million gallons

Air pollution, mainly from cars and industry, releases hundreds of tons of hydrocarbons into the oceans each year. Particles from the pollution settle, and rain washes these hydrocarbons from the air into the oceans.

Natural Seeps – 62 million gallons

Some ocean pollution is natural. Seepage from the ocean bottom may occur. Sedimentary rocks that contain oil may also erode, releasing the oil into ocean waters. Worldwide, the seepage only accounts for 62 million gallons, or about 2% of the oil found in the oceans. In North American oceans, this natural seepage becomes a much more serious problem. Natural seepage accounts for 62% of the oil in North American oceans. The Gulf of Mexico is the greatest natural source of oil in North American waters.

Offshore Drilling – 15 million gallons

Offshore oil production can cause some ocean oil pollution. Spills and operational discharges pour oil directly into the ocean waters. Fortunately, this source of ocean pollution is minimal.

Graphically Speaking

Segment 4

Leading Oil Spills

Oil spills are generally reported according to the number of barrels of oil that are lost in ocean waters. Tens of thousands of oil spills have occurred since the beginning of oil transport; however, few of these spills have been significant.

Date	Cause	Location	Barrels Lost
12/15/1976	*Argo Merchant* grounded	off SE Massachusetts	182,000
3/16/1976	Amoco *Cadiz* grounded	off NW France	1,561,000
7/01/1979	*Atlantic Empress* collided with *Aegean Captain*	off Trinidad	2,100,000
11/01/1979	*Burmah Agate* burns after collision	in Galveston Bay, TX	252,000
8/06/1983	Fire aboard *Castillo de Beliver*	off Cape Town, South Africa	1,750,000
12/06/1985	Drilling rig accident	off Texas Coast	326,000
11/10/1988	Tanker *Odyssey* grounded	off Newfoundland	1,100,000
3/24/1989	Exxon *Valdez* grounded	Prince William Sound, Alaska	245,000
4/11/1991	Tanker *Haven* grounded	off Genoa, Italy	100,000
2/15/1996	*Sea Empress* grounded	off South Wales, UK	500,000

(Set up a grid for a graph with the ships name on left and numbers from 100,000 to 2,400,000 across the bottom.)

Ocean in a Bottle

Segment 4

Purpose

To learn the difference between immiscible and miscible

To see what happens to ocean water during an oil spill

To see the effect of adding soap to ocean water to clean an oil spill

Materials

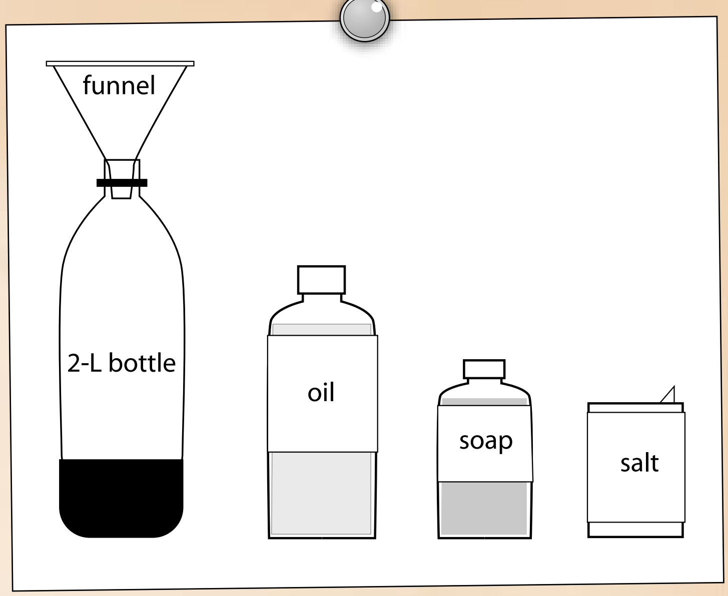
3 2-L, clear soda bottles (cleaned and with label removed)
metric measuring cup
water
vegetable oil
liquid detergent
funnel
paper towels
science journal

Background

Cleaning up after an oil spill can be a challenging and time-consuming task. Oil is immiscible in water. In other words, oil will not mix with water. When oil spills into the ocean, it will not combine with the ocean water, leaving floating oil globules or sediment oil deposits. All this oil must be cleaned up to reduce the harmful impact it can have on the environment. One method for cleaning up oil is to add detergents to the water. When detergent is added to an oil spill, it has a dramatic effect on the oil, causing it to clump together. The clumping makes the oil easier to remove from the water; however, detergent is miscible in water. In other words, soap will mix, or combine, with water. Adding detergent to water can help remove the oil from the water, but the detergent remains behind. It is almost like trading one pollutant for another.

Procedure

1. Measure 710 mL of water.
2. Using a funnel, pour the water into one of the 2-L bottles.
3. Measure 25 mL of salt.
4. Using a funnel, pour the salt into the bottle.
5. Gently shake the bottle to mix the water and salt so the mixture represents the ocean.
6. Measure and add 237 mL of vegetable oil to the bottle.
7. Put the cap on the bottle tightly.
8. Observe and record your observations in your science journal.
9. Shake the bottle to mix up the liquids.
10. Observe and record the appearance and behavior of the liquids.
11. With the masking tape and pen, label this bottle "oil."
12. Set the bottle aside and allow it to settle.
13. In another clean, 2-L bottle, add 710 mL of water.
14. Add 25 mL of salt and gently shake to mix.
15. Add 237 mL of liquid detergent.
16. Observe and record.
17. Put the cap on tightly and shake the bottle to mix up the liquids.
18. Observe and record the appearance and behavior of the liquids.
19. Label this bottle "detergent."
20. Set the bottle aside and allow it to settle.



Ocean in a Bottle

Segment 4

21. In the last clean, 2-L bottle, add 710 mL of water.
22. Add 25 mL of salt and gently shake to mix.
23. Add 118 mL of oil and 188 mL of shampoo or liquid laundry detergent.
24. Observe and record.
25. Put the cap on tightly and shake to mix up the liquids.
26. Observe and record the appearance and behavior of the liquids.
27. Label this bottle "oil and detergent."
28. Set the bottle aside and allow it to settle.
29. After the bottles' contents have settled, compare the appearance of the liquids in the 3 bottles.

Conclusion

1. Which liquids were miscible? Which were immiscible?
2. After the bottles were allowed time to settle, was there any change in the liquids?
3. What consequences do you think will come from using detergent to clean up oil spills?
4. Is adding detergent to the water in an attempt to clean up oil a good solution? Why or why not?

Extension

Try to clean up the oil in the 2 bottles that contain oil. Is it easy or hard? Why? Research methods that will clean up oil spills from water. Try some of them. Which ones are most effective? Least effective?

Dirty Oil, Oily Dirt

Segment 4

Purpose

To demonstrate the different types of oil and sediments

To learn how sediment is affected in an oil spill

Background

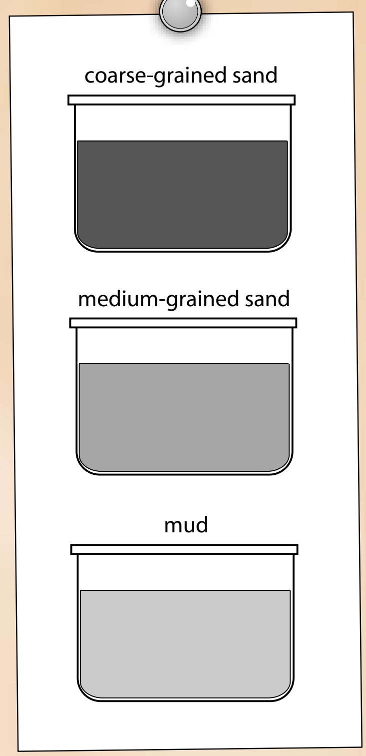
Beaches are composed of sediment. Sediments are pieces of rock that have been weathered and are carried and deposited by the ocean. Sediment types can range from very fine grained particles of such things as clay and mud, to very coarse-grained particles of sand and gravel.

Oil has two general types – heavy or light. Heavy oil is thicker and is used to fuel ships. Light oil is thinner and is used as diesel fuel or light crude oil. When an oil spill occurs in the ocean, oil can wash up on nearby beaches. Oil in sediment is harder to clean up than oil that is on the surface of the water.

Depending on the type of oil and the type of sediment, oil penetration in the sediment will vary. Typically, heavier oil penetrates sediment more slowly than lighter oil does. Finer grained sediment tends to absorb oil more slowly than coarser grained sediment. In this activity, you will conduct an environmentally friendly experiment to see the differences in oil absorption between fine- and coarse-grained sediment and light and heavy oil.

Materials

- 3 wide-mouth containers
- measuring cup
- coarse-grained sand or gravel
- medium- to fine-grained sand
- clay or mud
- molasses *(simulates heavy oil)*
- mineral oil *(simulates light oil)*
- small glass
- masking tape
- pen
- science journal



Procedure

1. Fill 1 container 2/3 full of coarse-grained sand.
2. With tape and a pen, label the container "coarse-grained sand."
3. Fill another container 2/3 full of medium- to fine-grained sand.
4. Label the container "medium- to fine-grained sand."
5. Fill the remaining container 2/3 full of clay or mud.
6. Label the container "clay" or "mud."
7. Make an indentation in each sediment type by pressing the bottom of a small glass into 2 places on the surface to create the 2 areas for oil to be applied.
8. Measure equal volumes of molasses and mineral oil.
9. Pour the molasses into one of the indentations in the "coarse-grained sand."
10. Pour the mineral oil into the other area of the "coarse-grained sand."
11. Observe and record the behavior of the liquids in your science journal.
12. Repeat steps 8–11 for the other two sediment types.
13. Because this activity is environmentally friendly, all materials can be disposed of normally.

Conclusion

1. What happened when the molasses made contact with the sediments? The mineral oil?
2. Did one of the simulated oils work faster than the other? Why or why not?
3. Was one of the sediment types quicker to absorb the oils? Why or why not?
4. What consequences of this activity compare to real oil spills?

Extension

1. Repeat this experiment with different oil types (vegetable oil, olive oil, peanut oil, etc.) and simulated oil types (maple syrup, chocolate syrup, etc.). Do you get the same results as before? Why or why not?
2. Research methods of cleaning up oil from sediment. Try to clean up some of the oil in your sediment. Which methods worked well and which methods did not work so well?

There's Oil in My Eggs

Segment 4

Purpose

To explain the impact of oil pollution on the environment and wildlife

Background

Large oil spills, although they are a relatively minor source of ocean oil pollution, can easily destroy an ecosystem. The same amount of oil can do more damage in some areas than in others. Coral reefs and mangroves are more sensitive to oil than sandy beaches or sea grass beds. Oil-covered fur or feathers can't insulate marine mammals and diving birds from cold water. When an animal cleans itself, it also swallows oil, which may be deadly. Birds with oil-coated feathers are often unable to swim or fly. Smithsonian Institution scientists monitored the effects of a 1986 oil spill in tropical North America. Five years later, mangrove sediments still held fresh, toxic oil. It could take 50 years for the mangrove ecosystem to recover fully from this single incident.

Materials

5 hard-boiled eggs
480-mL used motor oil
bird feathers (available from a pet store or craft store)
piece of fake fur material
magnifying lens
soap
clean water
large bowl
disposable plastic gloves
paper towels
science journal
clock or timer

Procedure

Egg

1. Place the hard-boiled eggs (including shells) in a bowl.
2. Cover the eggs with used motor oil. See diagram 1.
3. Mark the time of placement in your science journal.
4. Set the bowl aside for 30 minutes.
5. In your science journal, write down any predictions you have about what will happen to the eggs that are placed in the oil.
6. After 30 minutes, put on the gloves and remove one of the eggs from the oil.
7. Examine and observe the outside of the egg.
8. Record your observations and be sure to include the look and smell of the eggshell.
9. Peel the egg.
10. Examine the egg white and the inside of the shell.
11. Record your observations and note any evidence that the egg was in the oil.
12. Continue to open the egg by splitting it apart to view the yolk.
13. Determine whether the egg yolk shows any evidence of the oil.
14. Record your observations.
15. Read your original prediction and revise your prediction based on the information you have now gathered.
16. Repeat this process with a different egg after one hour, two hours, three hours, and the following day.
17. Compare your observations from the first egg to the last egg.

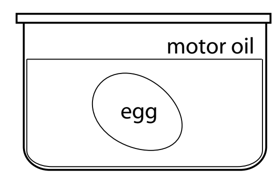


Diagram 1

Feather

18. Select a feather and examine it closely.
19. In your science journal, draw a picture of what you see.
20. Dip the feather in the used motor oil. See diagram 2.
21. Look closely at the feather and observe any changes.
22. Record your observations.
23. Predict how successful various cleaners will be in cleaning the oil from the feather.

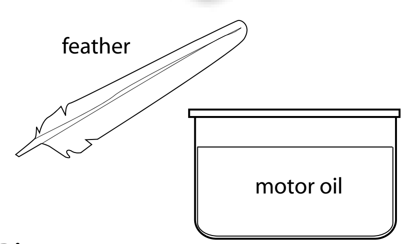


Diagram 2

There's Oil in My Eggs

Segment 4

24. Develop a plan to clean the oil from the feather.
25. Clean the feather following your plan.
26. Record how successful your cleanup efforts were and discuss the results with your group and class.

Conclusion

1. How did the oil affect the eggs?
2. What evidence did you have that the oil had penetrated the eggshell?
3. How did the oil enter the solid egg?
4. What effect did the length of time in the oil have on the eggs?
5. What can the tree house detectives learn from this experiment?
6. How successful were you at removing the oil from the feather?
7. What impact can an oil spill have on the ecosystem?

Extension

1. Using available research, find out about a major oil spill. Most oil spills are measured in the number of barrels lost. One petroleum barrel is equivalent to about 159 L. Determine how many 2-L soda bottles of oil were spilled by the accident you investigated.
2. Locate pictures of oil spills and their effects. Construct a collage to show what damage oil spills can do. Write either an instrumental or vocal musical piece that expresses the dangers of oil spills.

Blowin' Up a Storm of Oil

Segment 4

Purpose

To understand the effect wind has on oil spills

Background

Wind can have a great effect on water. Wind causes waves on the surface of the water and is also responsible for the surface currents that are present in the world's oceans. With strong wind movement, oil spilled in the ocean has a greater chance of being spread over large distances by waves and currents. In this activity, you will learn how wind can create surface currents and how waves move.

Materials

(per group)

1 shallow baking pan
1 sheet of dark construction paper
hole-punch
1 large, deep pan
2-speed electric fan
1 drinking straw
1 piece of tissue paper
tape
water
ruler
science journal

Procedure

Surface Currents

1. Fill the shallow baking pan with water.
2. With the hole-punch, punch out approximately 20 circles of construction paper.
3. Put the circles on the surface of the water near the left side of the pan.
4. Blow across the surface of the water. See diagram 1. The motion of the circles represents the motion of oil from an oil spill as the wind blows across the ocean surface.
5. Observe and record the motion of the circles in the water as you blow.
6. Repeat steps 4–5 several times.

Wave Energy

7. Cut a piece of tissue paper to 2 cm X 0.5 cm.
8. Tape the tissue paper to one end of a straw, leaving the paper hanging from the straw. See diagram 2.
9. Fill the deep pan with water to 2 cm deep.
10. Place the straw in one end of the pan at an angle. See diagram 3.
11. Using your hand, make waves in the water toward the straw.
12. Observe and record the tissue paper at the end of the straw.
13. Remove the straw and fill the pan with water until almost full.
14. With adult supervision, place the fan near the pan. Turn on the fan to low speed and have it blow across the water's surface. See diagram 4 (p. 82)
15. Observe the top of the water and record your observations.
16. Opposite the fan, place the straw in the water as before and observe and record what happens.
17. Place the small piece of foam material in the water. Carefully observe its movement and record your observations.
18. Turn the fan to a higher speed.
19. Observe and record the surface appearance of the water, the tissue, and the piece of foam.

Diagram 1

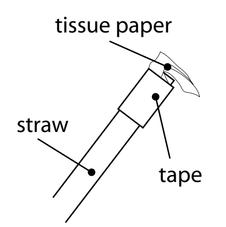


Diagram 2

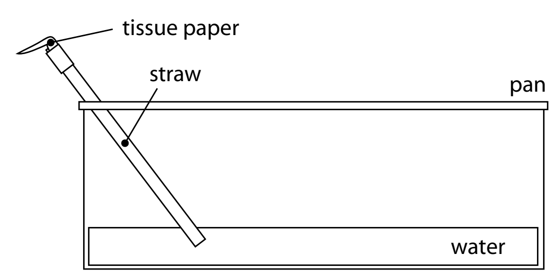


Diagram 3

Blowin' Up a Storm of Oil

Segment 4

20. Turn off the fan.
21. Measure 60 mL of cooking oil.
22. Mix several drops of blue food coloring into the oil until the oil is dark blue.
23. Slowly pour the blue oil onto the surface of the water.
24. Turn the fan on low. Observe what happens to the oil and record.
25. Turn the fan to a higher speed. Observe and record.

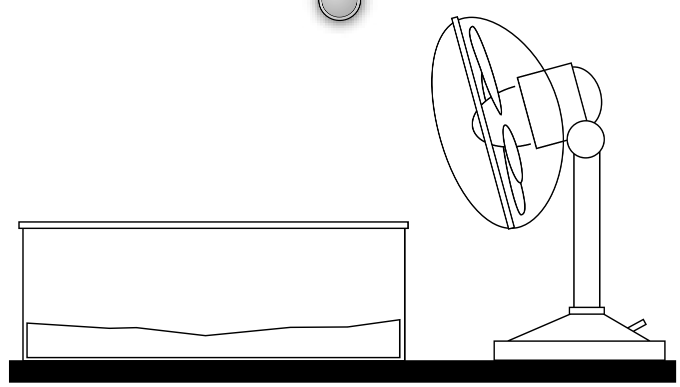


Diagram 4 fan blowing across pan of water

Conclusion

1. What happened to the circles as you blew on the surface of the water?
2. What happened to the tissue paper when you made waves with your hand? When the fan was turned on?
3. What happened to the surface of the water when the fan was turned on?
4. What happened to the piece of foam material when the fan blew on it?
5. What happened to the oil when the fan was turned on?
6. Why would scientists be concerned about strong winds blowing near an oil spill?

Extension

Research to find the main surface currents of the world and make a poster to show them. Explore why learning about surface currents is important. Why might NASA be interested in researching surface currents?

Ocean Odyssey Word Find

Word Find

Using the word bank, circle or highlight the words in the word find.

ocean	gas	submersible
surface current	density current	jack up
eddy	Gulf Stream	oilrig
filament	tides	waves
oil	thermohaline	upwelling
thermocline	Coriolis effect	topography
seeps	permeable	reservoir

O C E A N C A M P R Y N E A P T A M O O N F

I N M O M G A S S E D I T E J H G U Y I I I

L A C A M O R P M E T S Y A H E R A E L D G

R O R D E P E R I A K M C I C R I P A O U N

I N M A D I O M B N G K M S T M N T H T P E

G H E E D T I U A I U A G X R O S H S H W O

O K A I Y O R K N P I N U Y S C I E I Y E U

I J I L Z E S N M D C C L T U L L R R D L F

L L P L E T E T E C T O F L B I A M O R L I

U A I E E E W G E H Z N S N M N E O A S I L

R S M W R T I A E I T V T U E E R H R T N A

T Z Q U I C L I V T O E R M R I O A P N G M

C N L D S A I N D E R R E M S A S L E E H E

B G E A R S Z A I E S G A O I T P I N R A N

L I V E R T S S N G P T M C B I A N O R B T

O S P A C E S T A T I O N T L O C E I U I H

D E N S I T Y C U R R E N T E N E I T C T E

I E N E I G P S P E E S K O E S A C I E A R

E E R T C E F F E S I L O I R O C T R C T I

A K A T I I T G U D T B I R B I L L T A I N

R E S E R V O I R D R I R I O Y T I U F R G

G A E M O H S O B I T E R A T I V E N R U E

P E R M E A B L E C S N I K K I N Y N U P V

M F A E B Z X R Y H P A R G O P O T S S R E

Answer Key

Segment 4

Dispersing Dispersion

1. The corks spread out somewhat evenly in the pan.
2. The slightest movement of water and air molecules bumping into the corks caused the corks to begin to move about randomly.
3. Dispersion is the random movement of an object.
4. Dispersion could be a factor in how the tennis shoes washed up on their beach.

Don't Be Crude

1. A boom would be most effective for a small oil spill.
2. Answers will vary.
3. The absorbent material picks up oil and water.
4. In a real oil spill, people might use booms, skimmers, vacuums, absorbents, burning, chemical dispersants, or sinking agents to pick up the oil.
5. The contaminated material must be treated as hazardous waste and disposed of following the appropriate guidelines.
6. The dishwashing liquid made the oil congeal.
7. Answers will vary.
8. The chemical absorbents might add more pollution to the water.
9. Answers will vary.
10. Some of the factors that affect oil spill cleanup include wind, the size and location of the spill, currents, the source of the oil spill, and the condition of the water.

Graphically Speaking

1. Keeping records of oil spills helps us document changes in the environment as a result of the oil spill and may lead to more effective methods to clean up future oil spills.
2. Runoff across the surface area of the land is the source of the largest amount of oil spilled into the ocean.
3. The least amount of oil spill pollution results from offshore drilling.
4. Answers will vary.

Ocean in a Bottle

1. The soap was miscible. The oil was immiscible.
2. In the oil bottle, after some time, the oil returned to float on the surface of the water again. The soap remained mixed with the water.
3. Soap mixes with the water and could become another source of water pollution.
4. Answers will vary.

Sediment Penetration

1. The molasses took more time to absorb into the sediment. The mineral oil absorbed much quicker into the sediment.
2. The mineral oil was faster because it was lighter and flowed more easily.
3. The coarser grained sediment was quicker to absorb the oil than the finer grained sediment because the openings between the grains were larger, allowing the oil to enter more easily.
4. In a real oil spill, oil that reaches the sediment will flow into the sediment more quickly if the sediment is coarse grained. Lighter, more flowing oil will absorb into sediment more quickly than thicker oil that does not flow as easily.

There's Oil in My Eggs

1. The oil is absorbed through the eggshell and ends up in the egg white and egg yolk.
2. The egg white and egg yolk were colored darker by the oil.
3. The tiny openings in the eggshell allowed the oil to enter the egg.
4. The more time that passed, the more oil got into the center of the egg.
5. The Tree House Detectives could learn the effect of an oil spill on wildlife and the environment.
6. Answers will vary.
7. Answers will vary.

Wind Effect on Oil Spills

1. The circles moved around the dish in a clockwise motion.
2. The tissue paper moved when the waves were made and the fan was turned on.
3. The surface of the water formed waves when the fan was turned on.
4. Answers will vary.
5. The oil spread out over the surface of the pan.
6. The strong wind would spread the oil over a greater surface area than if the wind were not there.

Answer Key

Segment 4

Ocean Odyssey Word Find

O	C	E	A	N	C	A	M	P	R	Y	N	E	A	P	T	A	M	O	O	N	F
I	N	M	O	M	G	A	S	S	E	D	I	T	E	J	H	G	U	Y	I	I	I
L	A	C	A	M	O	R	P	M	E	T	S	Y	A	H	E	R	A	E	L	D	G
R	O	R	D	E	P	E	R	I	A	K	M	C	I	C	R	I	P	A	O	U	N
I	N	M	A	D	I	O	M	B	N	G	K	M	S	T	M	N	T	H	T	P	E
G	H	E	E	D	T	I	U	A	I	U	A	G	X	R	O	S	H	S	H	W	O
O	K	A	I	Y	O	R	K	N	P	I	N	U	Y	S	C	I	E	I	Y	E	U
I	J	I	L	Z	E	S	N	M	D	C	C	L	T	U	L	L	R	R	D	L	F
L	L	P	L	E	T	E	T	E	C	T	O	F	L	B	I	A	M	O	R	L	I
U	A	I	E	E	E	W	G	E	H	Z	N	S	N	M	N	E	O	A	S	I	L
R	S	M	W	R	T	I	A	E	I	T	V	T	U	E	E	R	H	R	T	N	A
T	Z	Q	U	I	C	L	I	V	T	O	E	R	M	R	I	O	A	P	N	G	M
C	N	L	D	S	A	I	N	D	E	R	R	E	M	S	A	S	L	E	E	H	E
B	G	E	A	R	S	Z	A	I	E	S	G	A	O	I	T	P	I	N	R	A	N
L	I	V	E	R	T	S	S	N	G	P	T	M	C	B	I	A	N	O	R	B	T
O	S	P	A	C	E	S	T	A	T	I	O	N	T	L	O	C	E	I	U	I	H
D	E	N	S	I	T	Y	C	U	R	R	E	N	T	E	N	E	I	T	C	T	E
I	E	N	E	I	G	P	S	P	E	E	S	K	O	E	S	A	C	I	E	A	R
E	E	R	T	C	E	F	F	E	S	I	L	O	I	R	O	C	T	R	C	T	I
A	K	A	T	I	I	T	G	U	D	T	B	I	R	B	I	L	L	T	A	I	N
R	E	S	E	R	V	O	I	R	D	R	I	R	I	O	Y	T	I	U	F	R	G
G	A	E	M	O	H	S	O	B	I	T	E	R	A	T	I	V	E	N	R	U	E
P	E	R	M	E	A	B	L	E	C	S	N	I	K	K	I	N	Y	N	U	P	V
M	F	A	E	B	Z	X	R	Y	H	P	A	R	G	O	P	O	T	S	S	R	E

On the Web

Convection Currents

1. When the hot water jar was punctured, the hot water rose to the surface because it is less dense than cold water. When the cold water jar was punctured, the cold water sank to the bottom because the cold water is denser than the hot water.
2. After the water sat overnight, the water temperature reached an equilibrium. The water turned purple because the red and blue mixed together.
3. The cold water was denser because it sank to the bottom.
4. Convection currents are currents that form due to uneven water temperatures. The colder water will sink under the warmer water because the colder water is denser.